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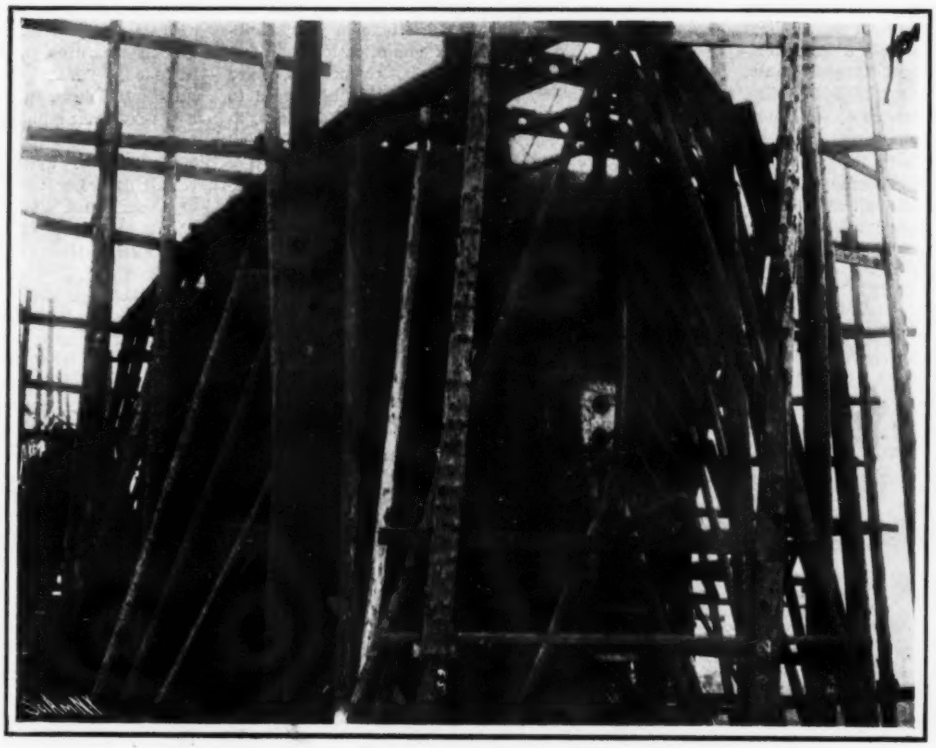
A NEW DEPARTURE IN SHIP CONSTRUCTION.

By the English Correspondent of SCIENTIFIC AMERICAN.

DURING recent years considerable advance has been made in the designing of freight vessels in order to facilitate and increase the handling capacity of bulk cargo, such as the turret, trunk, and cantilever frame vessels, and which have proved highly successful both commercially and structurally. Fundamentally, however, the principles of these varying designs have been the same as have prevailed in shipbuilding craft since the earliest days of constructing seagoing vessels. However, a new system has been evolved by Mr. J. W. Isherwood, which is a radical departure from existing practice. Instead of adopting the closely spaced transverse frames and beams with which we are so familiar, these are omitted, and instead transverse structural strength is secured by fitting directly on the plating a series of strong transverses at widely spaced intervals, extending where practicable completely round the vessel, sides, bottom, and deck, of sufficient strength to withstand the collective water pressure upon the skin of the ship. Furthermore, these are slotted to allow of longitudinal frames and beams being fitted continuously through these transverses. In those instances where transverse bulkheads are fitted for the purpose of subdivision as in bulk-oil steamers, these take the place of the transverses, since it is not essential that the bulkheads should be fitted for securing the requisite structural strength.

The accompanying illustrations, representing the first vessel to be built in accordance with this principle, convey a comprehensive idea of the system, and its departure from the generally followed lines is readily apparent. In every case the transverses are directly attached to the shell plating and deck of the vessel, which is of the utmost importance, since it enables the shell plating and deck plating, together with the efficient longitudinal support, to be considered as part of the transverse girder when calculating the comparative stresses. As already mentioned, the transverse members are slotted to carry longitudinal members in continuous lengths, to which the shell and deck plating between the transverses are supported. These longitudinals are considered as girders, and have a length corresponding to the interval between the strong transverses, and are of a strength not less than that of transverse frames of vessels of the ordinary construction, the comparative stresses being taken for each calculation under the same conditions.



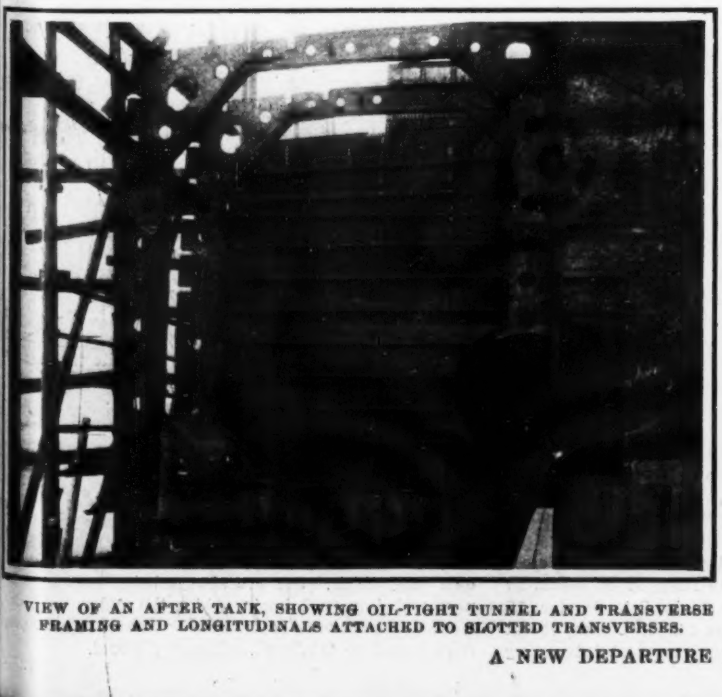
BOW VIEW OF THE OIL STEAMER, SHOWING THE LONGITUDINALS.

In vessels fitted with double bottoms an intermediate transverse floor either intercostal or continuous is fitted, to insure sufficient transverse strength for docking purposes and to support efficiently the longitudinal stiffening in the bottom.

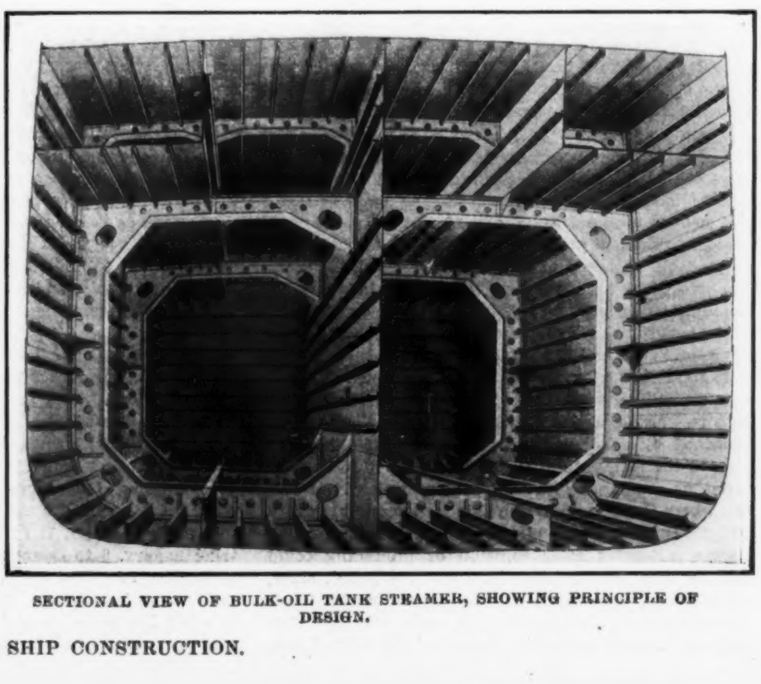
The petroleum-carrying steamer that is being built after this design has a length between perpendiculars of 355 feet, with an extreme beam of 49 feet 5 inches, and a depth at center of 29 feet. It is of the single-deck type, having a continuous expansion trunkway above the oil tanks. The propelling machinery consists of quadruple-expansion engines, which are placed amidships with three main boilers fitted abreast. A double bottom is fitted in the machinery spaces, and will be available for either oil fuel or water ballast. Reserve coal bunker accommodation is provided in the bridge space.

The main oil tanks are each 30 feet in length, and two transverses are fitted in each. They measure 35 inches deep at the side, 20 inches across the deck, 39 inches at the bottom, and 33 inches at the middle line bulkhead, formed of plates 0.45 inch thick, and connected to the shell plating by double angles. In the engine and boiler spaces practically the same spacing of the transverses is maintained. In the way of a double bottom the alternate transverses are fitted continuously around the bottom to the middle line, and the longitudinal girders are fitted in lengths between these transverses, to which they are adequately attached. The remaining transverses are stopped at the deep girder in the double bottom next the margin plate, and are then fitted intercostally between the longitudinals to the center line.

In order to avoid any interruption in the longitudinal strength the trunk is continued through the bridge, and it is interesting to note that the arrange-



VIEW OF AN AFTER TANK, SHOWING OIL-TIGHT TUNNEL AND TRANSVERSE FRAMING AND LONGITUDINALS ATTACHED TO SLOTTED TRANSVERSES.



SECTIONAL VIEW OF BULK-OIL TANK STEAMER, SHOWING PRINCIPLE OF DESIGN.

A NEW DEPARTURE IN SHIP CONSTRUCTION.

ments are carried out upon such lines as to provide practically the same longitudinal strength through the machinery spaces as in the way of the oil tanks, at either end of the bridge, the omission of the center bulkhead being compensated for by the longitudinally stiffened bridge and double bottom. In order to secure greater rigidity in this vessel the longitudinals, although fitted continuously through the transverses, are attached to the latter by angle bars.

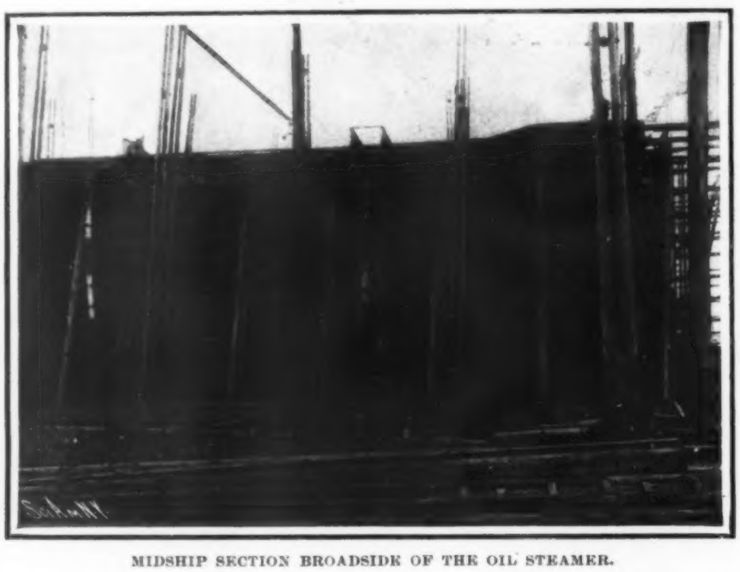
The system offers several advantages. In the first place, a vessel so built has a greater structural strength than one carried out upon the ordinary lines. Marine engineers have for some time past recognized the greater increase in strength possible by framing a vessel longitudinally, but until the present no attempt has been made to carry out the idea upon practical lines. Precisely what the degree of this increased longitudinal strength is may be gathered from the fact that it admits of the shell plating and deck plating, when of substantial thickness, being reduced below the recognized standards of the various classification societies. In the ordinary transverse-framed vessel the deck plating especially is deficient in longitudinal support, which fact is borne out by many vessels having buckled their decks between the beams. On the other hand, the Isherwood system, owing to all the plating being supported in the direction in which the greatest stresses occur, is able to withstand safely higher longitudinal stresses than a similar vessel framed in the general manner.

The system also appreciably facilitates construction, owing to the simplification of the structure and the ready accessibility to all parts. There is moreover a distinct saving in the quantity of material required, owing to its more efficient and economical distribution, and the saving effected in this direction represents an equivalent dead-weight increase on the same draft. So far as the holds are concerned, these are more spacious and free from obstruction. The new system adapts itself to a rearrangement of the pillaring, these being only required at the strong transverse beam ends. At first sight the depth of the transverses might appear to afford a cause of obstruction, but this disadvantage is more apparent than real. In the cases of ordinary freighters built upon these lines, the transverses can be spaced from 12 feet to 20 feet apart, and no broad horizontal plate stringers with bracket supports are necessary, nor is it requisite to fit widely-spaced strong hold beams with broad plate stringers on the ends, such as are often fitted in deep single-deck vessels framed in the usual manner.

It must be pointed out, however, that the greater the spacing of the transverses in this system, the heavier the ship, because stronger longitudinals at the side and deck become necessary. The most economical spacing is found to be from 12 feet to 16 feet, and there is practically no limit to the depth to which single-deck vessels without hold-beams can be built. Limbers can be reduced to a minimum, that part being almost recovered for either water ballast or freight, while between the transverses the space is quite clear of beam knees and tank-side knees.

The system also insures a reduction in maintenance repairs, while greater facilities are offered for damage repairs. Again, a vessel so built is not so liable to be broached by collision, since before the sides can be pierced the longitudinal members will have to be fractured, as compared with the ordinary web-framed vessel, where there are only the side stringers giving fore and aft support to the plating between the transverse frames. Repairs after collision or grounding could also be more expeditiously and easily effected, since, for instance, were injury inflicted to the bottom longitudinals, by running aground, it would only be necessary to remove the plate in the way of the injured part, when the longitudinals would at once be accessible without moving any of the plating across the bottom, while similarly collision damage could be repaired with equal rapidity and facility owing to accessibility and simplicity of the structure.

The system has been approved by the classification societies comprising Lloyd's, Bureau Veritas, and the British Corporation Registry under the highest classification of each.



MIDSHIP SECTION BROADSIDE OF THE OIL STEAMER.

WRECK STATISTICS FOR 1907.

LLOYD'S wreck statistics are always a mine of information to the commercial and shipping man, and an inexhaustible source of suggestion to the man who may be neither, but yet has an understanding mind, receptive to everything of interest to his country or mankind. Sea traffic is surely such a thing; it includes interests of much more moment than merely trade matters, although these enter into them, and of course it is chiefly with respect to them that we have here to deal with wrecks. The annual statistical summary of vessels totally lost, condemned, etc., is strictly a statistical and business document.

One can hardly, nevertheless, look it over without a thought of the enormous degree in which modern methods of sea transport, by increasing the size and speed of vessels, facilitating operations in port, facilitating telegraphic and postal communication, and improving the construction of ships themselves, have directly or indirectly reduced the risks which used to be attendant on all over-sea operations. The risks, in this diminished degree, still exist, and still demand and receive the attention they deserve. We would like to be able to put into some comprehensive and comprehensible form figures showing in what degree maritime risks have really been diminished, say, since the introduction of steam; but there are so many things to consider in this aspect that we will, at all events for the present, content ourselves with quoting actual facts, on the indisputable basis of Lloyd's return; here we are on safe and non-speculative ground.

It is satisfactory to see that the percentage of losses of steamers continues to decrease, both as to number and tonnage. In 1907, which, of course, is the year dealt with, the percentage was 1.76 on the number of vessels, and 1.75 on the tonnage. This is quite a considerable improvement on the averages since 1897, which were—1897 to 1901, 1.99 on number, and 2.01 on tonnage; 1902-1906, 1.91 on number, and 1.77 on tonnage. It is not so satisfactory to see that the proportion of sailers lost has increased; but we must remember that it is a proportion, and not an aggregate, and that the proportion of sailing tonnage built to that of steam tonnage is always decreasing, so that the older sailers are gradually being broken up and condemned as well as lost in other ways, and still enter under those heads into the lost list. Here, again, we are tempted to enter into speculative statistics; but Lloyd's firmly, and doubtless rightly, refrain from publishing anything but actual facts; and to these we return.

The total steamer losses in 1907, "as reported to July 1, 1908," were 273 boats, of 253,613 net and 408,328 gross tons. This includes losses under the usual heads, viz., abandoned at sea (6); broken up, condemned, etc. (1); burnt (17); collision (40); foundered (35); lost, etc. (could not be otherwise classified) (3); missing (19); wrecked, stranding rocks, etc. (152). Of these 273 boats 90 were British, 19 belonged to British Colonies, 11 to the United States, 2 to Austria-Hungary, 6 to Denmark, 1 to the Netherlands, 14 to France, 27 to Germany, 4 to Italy, 27 to Japan, 20 to Norway, 7 to Russia, 13 to Spain, 7 to Sweden, 15 to other European countries, and 10 to Central South America. But what is perhaps the most interesting comparison is that of the percentage of losses to the number of steamers and tonnage owned by each country. Here the U. K. figures well, and better than it has latterly done. Its percentage on number is 1.60, and on tonnage 0.95. Three countries only, Austria, the Netherlands, and Italy, have better averages; theirs are as follows, giving first the percentage on number and then that on tonnage: Austria-Hungary, 0.64 and 0.91; Netherlands, 0.22 and 0.08; Italy, 1.01 and 0.59. Russia and Sweden and Denmark have averages, on the whole, about the same as ours; the U. S. A. has less on number, but much more on tonnage; and it must be also observed that where countries have only a small merchant navy, the item of chance (we must so call it) enters largely. For instance, Austria happens to have lost only two boats in all, the Netherlands only one, Italy four, and Russia seven of small tonnage. Their figures, therefore, can hardly be taken as real percentages, and certainly not as averages. Of the great ship-owning nations the percentages besides those given or indicated are, France, 1.73 and 1.26; Germany, 1.58 and 1.25; Japan, 3.38 and 3.15; Norway, 1.69 and 2.18; Spain, 2.78 and 3.40. Of these, it will be seen, we are much ahead in what concerns safety. Our own Colonies have the figures of 1.56 and 1.59. Italy and Austria-Hungary, both with merchant navies of over 400,000 tons, may claim the maximum of safety. Steamers on the Great Lakes of America are not included. Turning to sailers, we find 367 losses; or nearly 100 more in number than steamers. Here we find very remarkable figures. England lost 41 vessels; British Colonies, 29; the U. S. A., 94; France, 22; Italy, 20; Norway, 84; Russia, 20; Sweden, 25, other countries a few each. Again taking percentages first of the number of vessels, and then of the tonnage owned by respective countries, we find Germany, Italy, and Austria-Hungary at the top, with 1.31 and 1.70, 2.82 and 3.01, and nothing, respectively, but here Austria should not count, as she had no losses out of only 14 sailers owned, while Italy owned 710. The U. K. has the figures of 3.35 and 3.09; her Colonies rather more; the U. S. of America 4.86 and 4.83 (on the largest sailing fleet of any). France, Denmark, Russia, Spain, Sweden, approximate to our own figures; but Norway, with the heavy number of 980 vessels, and the third largest sail tonnage of any country, has the startling, and indeed tremendous percentage of 8.57 on number, and 8.16 on tonnage—nearly double that of America, the runner-up in losses, and more than double that of our own and other great maritime countries. Germany thus has the best figures; she lost but 5 vessels out of 381 owned. Japan does not figure in the sailing vessels table.

We need not go into particulars of that showing the steam and sail losses combined; but, perhaps, as interesting as the number of losses, is their cause. Here we cannot usefully shorten, or do better than quote, the remarks appended to the publication of the tables by Lloyd's Register itself:

"The summary exhibits interesting data as to the relative frequency of the different kinds of casualty, etc., which conclude the existence of vessels. Strandings and kindred casualties which are comprised under the term 'wrecked,' are much the most prolific cause of disaster. To such casualties are attributable 42.7 per cent of the losses of steamers and 35.7 per cent of the losses of sailing vessels. The next most common termination of a vessel's career is by condemnation, breaking up, etc., 23.6 per cent of the steamers and 34 per cent of the sailing vessels removed from the merchant fleets of the world being accounted for in this manner. Of the remaining causes of loss, collision is the most general for steamers (11.2 per cent); while, for sailing vessels, cases of abandonment at sea come next in order of frequency (8.4 per cent).

The percentages just given are based on the present return alone, but the order of frequency of the several classes of casualty appears to be normal. Cases of abandoned, foundered, and missing vessels are no doubt frequently more or less similar in the circumstances of loss. If these be taken collectively, they comprehend 16.9 per cent of the steamers, and 20.1 per cent of the sailing vessels removed from the mercantile marine during 1907."

There is another thing to be considered in this connection, namely, the nature of the trade in which the vessels are engaged. Thus, the Norwegian sailers go all over the world in various trades, while the Americans are confined more to certain special routes, and so on. These things cannot be tabulated; but they affect the fairness of a comparison between the percentage of loss of the various nationalities. So also do such facts as the nature of the vessels themselves. Japan and Norway, for instance, might be expected to have their percentages of losses of steamers increased because they are buyers of second-hand, and therefore less seaworthy vessels, than those running under our own flag, which latter are always being increased by new and improved boats, while the older ones are weeded out by sales as well as by losses. This again cannot well be tabulated.—Shipping World.

AMERICAN POWER TRANSMISSION.*

A REVIEW OF RECENT WORK.

BY DR. LOUIS BELL.

Much of the power-transmission work of the last five years or so has been of an unobtrusive character, mere extension without material change of what had gone before. In many instances, indeed, there was no need of innovation since the common voltages and types of apparatus proved perfectly adequate. As time has gone on, however, the tendency has been to use higher and higher voltages. The prevailing high prices of copper have served to stimulate this tendency of late, so that the use of moderate voltage, say 10,000 to 14,000, derived directly from the generators, has declined, and even for relatively short lines the voltage is frequently raised by transformers to 20,000 or more, the generators themselves being commonly wound for 2,000 to 2,500 volts.

In fact, the use of generators for more than this moderate figure is now rare in the ordinary hydroelectric transmission plants, and is chiefly confined to steam plants serving large lighting or electric railway systems in which the use of underground cables acts as a limitation on the practicable voltage.

On the other hand, the voltage of transmission in ordinary practice has been steadily rising, not by sensational leaps, but by steady progress, until at the present time one can scarcely classify anything short of 30,000 volts as of really high voltage, and double this figure is reached in something like a score of cases. In two notable plants, the Grand Rapids-Muskegon system in Michigan, and the Kern River line of the Los Angeles (Cal.) Edison Company, the working pressure is now approximately 75,000 volts, and the security of the service is sensibly as great as in the plants working at 50,000 to 60,000 volts. It is probable that within a year this limit may be raised to 100,000 volts or more, since at least two plants now under construction are being equipped for such working. Nearly all high-voltage transformers are equipped with one or more taps on the high-voltage side, so that they can be worked at 5 to 10 per cent below their full voltage, and in many cases plants start up with the raising transformers connected in mesh and afterward gain assurance and pass to star connection and full voltage. The use of composite three-phase transformers is rapidly increasing as experience has been gained in transformer insulation, and this is the common type in high-voltage work on any considerable scale. There is no serious difficulty in providing transformers for 100,000 to 150,000 volts, or even higher pressures, and the possible advance in voltage depends directly upon line insulation.

Heretofore the factor of safety in the insulators has been rather unsatisfactory. It is easy to get porcelain of good quality but difficult so to design the structure as to gain security against surface leakage. When an insulator is dry and clean its power of holding up against extreme electrical strains depends chiefly on its external dimensions—i. e., on the distance which must be jumped by a discharge from the wire over the edges of the petticoats to the pin. In wet weather, and particularly in a driving drizzle, its power of resistance depends almost entirely on its ability to preserve enough dry surface in the interior to check surface leakage, since a wet surface is a conducting surface. In dry weather a big insulator with flaring petticoats may prove entirely dependable and yet fail entirely under a searching rain. Insulators with deep and narrow crannies between the petticoats are better under a wet test, although they may give trouble when dust storms are frequent. Of the two 75,000-volt American plants one (in the dry California climate) is on large pin-type insulators, with moderately flaring petticoats, while the other is chiefly on the later type of suspension insulator.

In this type several porcelain bells, either plain or with concentric petticoats, are strung together like a series of Japanese gongs, the uppermost being carried by the cross-arm, the lowest supporting the wire. The bells themselves are all of the same size, ranging from 10 inches to 15 inches in diameter, and are fastened together by metallic links variously held in position. In the simplest form the bells are channeled as in some strain insulators, and the linking wires loop through each other from above and below, holding the porcelain in compression between them.

Insulators of this sort are used with two to five or more bells in series, and are undoubtedly capable of enduring high voltages far better than any pin-type insulator yet designed. It is very difficult to find any pin-type insulator that will stand 100,000 volts in a driving spray for even a few moments, and even the best of them generally will flash over at 80,000 to 90,000, while even so few as three bells in suspension will hold 100,000 volts during a long "wet test." The two projected lines mentioned are being equipped with the suspension insulator, which appears to be the chief recent improvement in high-tension transmission.

Late constructions have been developed in the direction of reducing the number of supports by lengthening the spans. Moderately long spans on both steel and wooden poles have, of course, been used, but the Guanajuato transmission line in Mexico initiated the plan which has since been extensively followed. This line was carried in spans of 500 to 600 feet, on steel windmill towers, and while great trouble was experienced at first with the insulation, improved forms of insulator have made the plan thoroughly practicable. Most recent American lines have followed it and with fair success, although there has been a tendency to use too light and unscientifically designed towers which have occasionally failed and are of dubious life. For economy two complete circuits have often been run on the same towers, a precarious practice, as is evidenced by the fact that most such lines have simultaneously lost both circuits in case of any really serious difficulty.

The American tendency to use so-called "standard" stuff for cheapness has until recently prevented scientific design of pole lines as mechanical structures, but there are now signs of improvement in practice which will eventually promote economy of material.

As a whole, the American high-voltage long-distance transmission lines perform very well, but there are unquestionably more brief suspensions of service than most operating companies would care to admit. Foreign bodies falling upon or blown upon the circuits and lightning are the chief sources of trouble. Recent circuits are spaced widely, generally on the basis of about a foot for each 10,000 volts in the higher voltages, and hence escape many accidents of the former class, but lightning remains the thing most to be feared. Many circuits, especially those on steel towers, are equipped with a grounded wire strung above the circuit wires, which is supposed to deflect lightning discharges to earth. On some lines it seems to have been very effective, on others of small value. Probably a direct stroke of lightning upon the line would do damage in spite of it, while induced discharges would often be successfully averted.

An electrolytic lightning arrester composed of aluminium dry cells of large surface, stacked in series, has been recently introduced, and very fervent claims are made for it. Theoretically it promises well, but it has been nowhere long enough in use to enable one to speak confidently of its merits. Some of the most important systems depend almost entirely on the horn type of arrester of large dimensions, but most use elaborate forms of multiple gap arresters shunted to earth from several points.

In power-house design little of novelty is presented. The generators and transformers are in larger units than formerly, and the controlling devices are more thoroughly worked out. In fact, American engineers are making rather a fetish of switchboard apparatus, so that its cost has become very burdensome, and its complication introduces not a little risk of trouble from the enormous amount of wiring involved.

The frequency of late has remained unchanged on a general basis of 60 cycles, even for the longest transmissions. The two notable exceptions are Niagara at 25 cycles and the great network of the Los Angeles Edison Company at 50 cycles. Both these date from the early days of transmission, and have simply adhered to the original frequencies. The longest transmission is still upon the system in Northern California, 232 miles from De Sabla to Sauselito, with the line from Niagara to Syracuse (N. Y.) a good second, at 165 miles, and several California lines not far behind. It is worth noting that there have been no material difficulties from the use of 60 cycles over the longest distances, and the long lines perform about as well as those much shorter.

The most interesting improvements in practice have been in the line of distribution. There is a strong tendency to unite a large group of hydro-electric plants into a single network whenever possible. Such great systems are to be found in Northern California, Southern California, Utah, and Colorado, to say nothing of many less complete examples elsewhere. The gain in continuity of service from the use of a network is very important, since serious interruptions are very unlikely when each point can be fed from two or more directions. There is a great gain, too, in simplicity of the equipment, since each plant can be organized with the advantage of relying upon others. For example, a single water power can be utilized by one or two big generators and transformers depending on another power in case of breakdown, and yet not itself seriously affected by trouble in another plant on account of the cushioning effect of the long intervening circuits. It is quite certain that a group of moderate powers if intelligently developed can be brought into service more cheaply and can give more reliable service than a single plant of equivalent output organized in the usual manner and distributing power, like Niagara, chiefly along radii.

There is also the opportunity of utilizing in a single system hydraulic plants located on different watersheds and with different circumstances of high and low water so as to improve very greatly the conditions of hydraulic utilization. This situation has developed but slightly as yet, but it is highly promising.

In local distribution of power and light there have been some changes for the better. Most plants still depend mainly upon hand regulation, but of late some rather successful forms of automatic regulator for three-phase circuits have been brought out. The governing of the waterwheels, too, has been improved, and for the high heads the introduction of a successful type of needle valve has checked the waste incident to the use of deflecting nozzles for the impulse wheels. The palm for high head (920 meters) still rests with Switzerland, although the Rocky Mountain district furnishes some sensational falls.

In distribution work one interesting novelty has appeared in connection with a few transmission plants—the use of the so-called "magnetic" arc operated from mercury rectifiers. The arc itself gives an admirable light for out-of-door work, and the rectifiers, although of somewhat uncertain life, have been greatly improved and are fairly upon a commercial basis. In the main, American engineers still adhere to the alternating-current inclosed arc worked from constant-current transformers in spite of its poor efficiency as an illuminant.

Underground distribution is still unusual, and is in great measure confined to the old districts lighted by low-tension, direct-current mains. Now and then there has been a case of a high-voltage transmission taken underground from outlying districts to a sub-station, but the high-voltage cable problem is one that American engineers have never been called on seriously to face. High-voltage lines are run freely through well-settled country, and the risk has proved to be practically nil, since everybody knows that it is unsafe to meddle with the circuits, and the wires are so carefully erected that breaks are very rare and the grounded circuit is at once out of action. What few crosses of transmission lines with others have occurred have quite invariably been due to the shabby construction of the other circuits. With the steel construction now in vogue and insulators with ample factors of safety there is no material risk in using overhead transmission circuits of any voltage in almost any situation.

* From the London Times Engineering Supplement.

Linen fibers are usually distinguished from hemp fibers by the shape of the ends of the fibers; the linen fiber gradually tapers to a point, whereas the hemp fiber exhibits a blunt, rounded or knotty end. The sections of the linen fiber are polygonal while those of the hemp fiber are of more irregular outline. Hanausek treats the fibers with a solution obtained by adding an excess of sulphuric acid to a solution of potassium bichromate. In a few seconds the fibers begin to swell and the liquor near to the fibers turns green. Air bubbles appear and assist in causing the active yellow liquor to displace the now inactive green liquor around the fibers; this movement is further assisted by tilting the microscopic slide on which the fibers are resting. The linen fibers are found to swell more quickly than the hemp fibers. The surface of the fiber becomes irregular and dark patches are produced in both cases. These patches are seen to be more pronounced in the case of the hemp. Hanausek, however, attaches most importance to the appearance of the linings of the canals of the treated fibers. The canal of the immersed linen fiber is somewhat similar to that produced on treatment with cuprammonium solution; it is very narrow, wavy, irregular and broken. The canal of the hemp fiber, on the other hand, is a straight, continuous, very plastic tube, which is in no case broken or undulating.

ELECTRICAL VISION AT A DISTANCE.

THE ARMENGAUD SYSTEM.

BY A. TROLLER.

FOR the last thirty years inventors have been vainly endeavoring to solve the problem of electrical vision at a distance, which is related to but not identical with telephotography, or the electrical transmission of pictures. M. Jules Armengaud has recently suggested a method which appears promising.

The problem, by the way, has long been solved, on paper. M. Armengaud himself, in presenting Bell's photophone to the society of engineers in 1880, pointed out the results that might be expected from the employment of selenium for the purpose of electrical vision, and cited the experiments of De Paiva, Senlecq, Ayrton and Perry, Desprez, Leblanc, and Bréguet. This was shortly after the invention of the Bell telephone had demonstrated the possibility of transmitting and reproducing the vibrations of sound by means of wires and electric currents, and the application of similar methods to luminous vibrations naturally suggested itself.

The electrical conductivity of selenium varies according to the intensity of the illumination to which it is exposed. Hence a sort of artificial retina can be made of selenium which will, like the retina of the eye, react to the varying degrees of light and shade of an image projected upon it, the reaction taking the form of variations in the strength of an electric current flowing through a wire which may be compared to the optic nerve. At the other end of the wire it would be necessary to reconvert the variations of current strength into variations of luminosity and to redistribute these in accordance with the geometrical plan of the original image or object. Methods of accomplishing this have been devised by Korn, Belin, Berjonneau, and other experimenters in telephotography, but these methods do not make possible direct vision at a distance, for the electrical variations which correspond to the various parts of the image are necessarily transmitted singly and successively, while in direct vision all parts of the object are seen simultaneously. This difficulty can be overcome by making use of the persistence of luminous impressions on the retina. If the various parts of the object are presented successively to the sensitive selenium cell with such rapidity that the whole object is, so to speak, explored in 1/10 second, the sensation produced in the eye of the observer at the receiving station by the first part of the object (through the intermediation of the selenium cell, the connecting wire and the receiving apparatus which converts electrical into luminous effects) will not have become effaced when the sensation due to the last part of the object is produced.

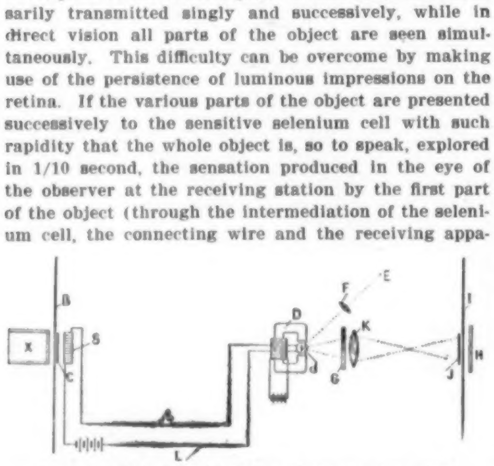


FIG. 1.—DIAGRAM OF APPARATUS FOR TRANSMISSION OF VISUAL IMAGES.

X. Camera. B, C. Cinematograph bands. S. Selenium. L, L'. Wires connecting stations. D, d. Oscillograph. E. Auxiliary source of light. F, K. Lenses. G. Scale of tints.

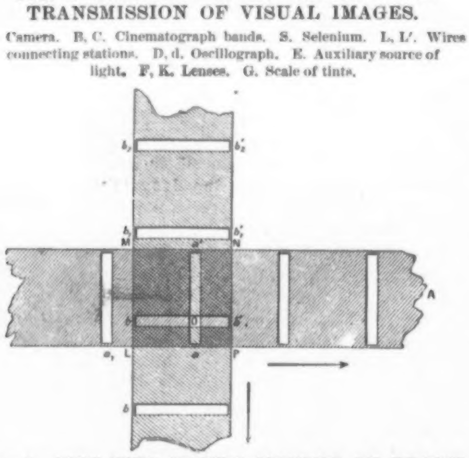


FIG. 2.—THE TWO BANDS MOVING IN FRONT OF THE IMAGE.

It has hitherto appeared impossible to attain the requisite rapidity of the transmitting and receiving apparatus. Ingenious but fruitless attempts were made by Weiller in 1889, Dussaud in 1898, and Coblyn in 1902. Armengaud has now attacked the problem by a method suggested by the cinematograph, using mechanism similar to that employed in giving to moving picture films their very rapid but interrupted motion. In the first place an image of the object is formed on the ground glass *B* of a camera *X* (Fig. 1). This image is then divided, by a cinematograph mechanism, into little squares which are successively projected, for equal minute intervals of time, upon the selenium cell *S*. Hence the variation produced in the current which flows through the cell and conducting wire depends solely upon the brightness of the small portion of the image which is uncovered by the moving window. The rate of motion of the apparatus is such that the entire image is traversed in less than 1/10 second. This result is accomplished by means of two endless bands moving in front of the ground glass on which the image is formed. One of these bands moves horizontally and is pierced by narrow vertical slits, the other moves vertically and has horizontal slits (Fig. 2). Hence the only part of the image uncovered at any given instant is a small square at the intersection of a vertical and a horizontal slit. The width of each slit and consequently the width and height of the square opening are equal to one-tenth of the height of the image. If the image is conceived as divided into little squares, each of these squares may be exposed in succession by the intersecting slits of the moving bands. Thus, during the fraction of a second, in which the vertical band *B* is motionless, the horizontal slit *b b'* occupies, for example, the position shown in the diagram (Fig. 2), while the horizontal band *A* moves so that the little square opening formed by the intersection of *b b'* with the vertical slit *a a'* sweeps over the entire length of *b b'*, or the width of the image. The vertical band then suddenly moves downward through a distance equal to the height of the image. The distance between consecutive slits being only 9/10 of this height, the slit above *b b'* is thus brought to a position immediately above that formerly occupied by *b b'*, where it is in turn traversed by the vertical slit which follows *a a'*. The velocity of the horizontal band is much greater than that of the other—too great to be practicable with an intermittent motion. This band is, therefore, moved with uniform speed. For an image 19 millimeters (0.75 inch) high and 25 millimeters (1 inch) wide, divided into 130 squares measuring 1.9 millimeters (0.075 inch) on each side, the mean velocity of the vertical band should be 25 centimeters (10 inches) and that of the horizontal band 50 centimeters (20 inches) per second. M. Armengaud has also devised several other methods of subdividing the image.

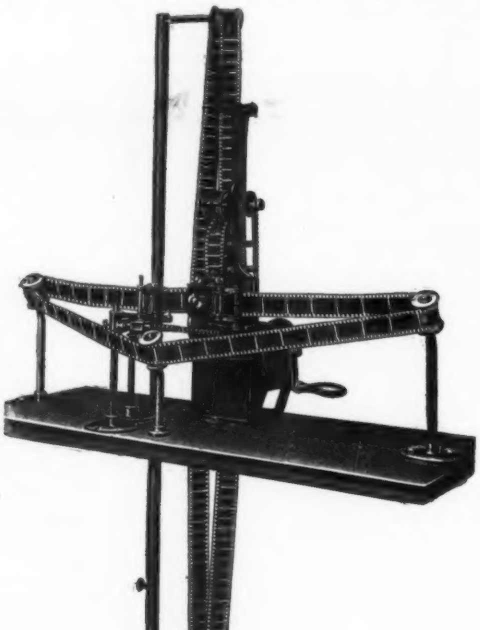


FIG. 3.—FRONT VIEW OF ARMENGAUD TRANSMITTER.

Each element of the image impresses the selenium for a very small fraction of a second and is immediately succeeded by another element. Hence, as the change in the conductivity of selenium does not take place instantaneously when the illumination is changed, there would be an overlapping of effects if only one selenium cell were used. This difficulty is met by employing a number of cells which form the faces of a prism rotating on an axis perpendicular to the beam of light. The cells are exposed successively and each has an interval of rest sufficient to enable it to recover from the effect of one exposure before it is exposed again. It must be admitted, however, that the construction of this part of the apparatus will be a difficult and delicate problem, and the success of the whole method will probably depend on its solution. In order to reconvert electrical into luminous variations at the receiving station Armengaud intends to employ either Belin's apparatus (Fig. 1), using Blondel's oscillograph and a graded series of tints, or the method of Senlecq. At present he is engaged in perfecting the cinematographic transmitter described above (Figs. 3 and 4).—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

MAKING BLUE-PRINTS WITHOUT A FRAME.

By C. A. BURNAP.

IT may not have occurred to many readers that blue-prints of small size can be made without a blue-printing frame. An ordinary window can be used if the sun shines through it, and a blue-print can be made in any window. An ordinary thick bath towel is placed behind the print, the tracing being placed against the glass. The towel should be folded into two or three thicknesses and arranged so that no wrinkle or uneven part lies against the print. A small drawing board may then be placed against the towel, but it is better to tack the towel at its corners to the board. It is also advisable to attach the tracing to the printing paper by small gummed stickers, to keep them in the proper position and to prevent sliding. Ordinary stickers cut into narrow strips will be sufficient, and need engage only a narrow surface on both the paper and the tracing, to serve the purpose. The print can then be frequently looked at without

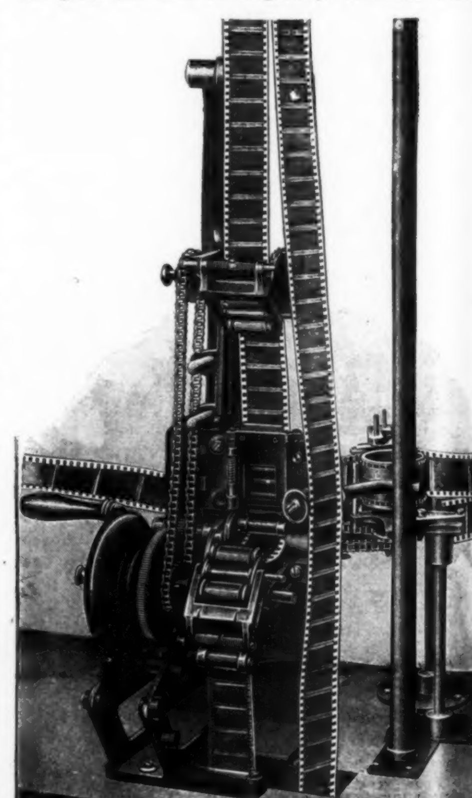


FIG. 4.—REAR VIEW OF ARMENGAUD TRANSMITTER.

disturbing the relation, and can be easily torn off without injuring it or the tracing. Fragments of the stickers are easily scraped off. The printing paper and tracing can be held by a blank projecting edge against the window while the towel and board are being pressed against them. Any suitable means for holding the board in place may be used.

Another improvised printing outfit consists simply

in spreading the towel evenly upon the floor where the sun can strike it, placing the printing paper and tracing upon it, and then merely covering these with a thick plate of glass. When first laid down, the glass may be pressed downward with considerable pressure, after which its weight alone will be sufficient to keep the paper smooth. This will be the case if two or three thicknesses of bath towel are used. This plan works perfectly for sheets 10 x 15 inches and below, this being the size used by the writer. Larger prints could doubtless be made in this way if weights were put upon the corners of the glass.

Another very practical way of making small prints is to use a smooth board with a slightly curved face. A tack placed in each corner of the tracing and print will cause them to snugly lie against the curved surface of the board, making a sharp and clear print. No glass is needed.—Machinery.

AN AIR-DRIVEN TYPEWRITER.

A LABOR-SAVING OFFICE DEVICE.

BY OUR BERLIN CORRESPONDENT.

From time to time efforts have been made to provide some mechanical means for operating typewriters, so as to relieve the typewritist of any undue exertion, and cause the machine to depress the characters with perfect uniformity regardless of variations in the striking of the keys. At the Berlin Exhibition of Inventions a typewriter of this character was recently shown, in which compressed air is used to operate the mechanism. The compressed air does all the work, and the typewritist needs only to select the characters that are to be struck by merely touching the keys. There are no valves in the machine, because their place is taken by the fingers of the operator. The underlying principle of the machine is illustrated in Fig. 1. *A B* is a fixed tube, the end *A* of which communicates with a chamber covered by a diaphragm, while the end *B*, which is designed as a key, is open. At a point *C* in the tube, a supply of compressed air is introduced through a fine pinhole. This air normally escapes from the key as fast as it enters the tube, and hence has no tendency to flex the diaphragm; but when the key is touched, the aperture therein is covered by the finger of the typewritist, and the air backing up in the tube moves the diaphragm to the position shown by dotted lines.

It will readily be understood that this system could be repeated for each key, and the deflection of the diaphragm could be used to throw a type against the platen; but in order to make one diaphragm serve for all the characters of the typewriter, the arrangement shown in Figs. 2 and 3 is used. In these illustrations,

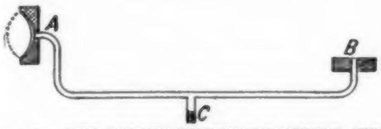


Fig. 1.—DIAGRAM ILLUSTRATING THE PRINCIPLE OF OPERATION.

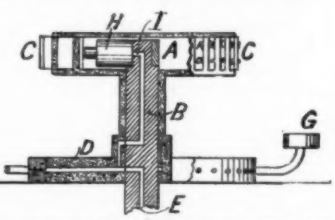
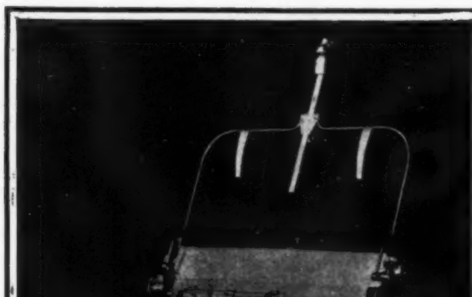


Fig. 2.—SECTION THROUGH THE TYPE WHEEL AND REVOLVING VANE.

A represents a type wheel constantly rotating around the shaft *B*. The types *C* are thrown out radially against the platen. Below the type wheel but mounted to rotate therewith is a vane *D*, through which an air passage is drilled. The air channel is branched to communicate with the passages *E* and *I* in the fixed shaft *B*. The passage *E* connects with the compressed-air supply, while the passage *I* leads to the diaphragm chamber *H*. A finger projecting from the chamber operates to strike the type *C* against the platen whenever the diaphragm is flexed. As the typewheel and vane *D* revolve, the end of the latter sweeps around the inner periphery of a fixed ring *F*. This ring is provided with openings connected by tubes to the keys of the keyboard. Normally, the air in the rotating vane escapes through the keys by way of these openings; but when a key is covered by the finger and the vane in its circuit passes the closed tube, the flow of air through the vane is momentarily checked, and instantly the type passing before the diaphragm at the time is thrown by the diaphragm against the platen. The character is printed in less than 1/120 of a second. This extreme rapidity of operation causes the printing to be done with remarkable sharpness, and the momentary stoppage of the wheel while the character is being impressed is hardly observable. The type wheel thus practically moves continuously. It will readily be understood that in certain cases a number of keys may be touched at the same time, and the various characters will be printed in rapid succession. By a

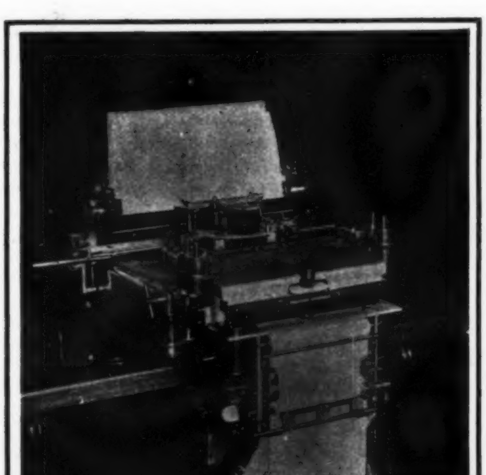


A TYPEWRITER OPERATED BY COMPRESSED AIR.

proper arrangement of the keyboard some of the shorter words and common syllables may thus be printed at a single operation. On this account the air-driven typewriter, which if operated in the ordinary way will allow the speed of any other form of typewriter, by the simultaneous printing of several letters is enabled to do even faster work than the ordinary typewriter. The use of compressed air reduces the number of parts of the machine, and it is said to be made up of 80 per cent less members than the ordinary lever typewriter. The mechanism is thus simplified, and is subjected to far less wear and tear than in the ordinary machine.

A special inking device patterned after that used in printing presses does away with the usual ribbons or ink pads, and insures an absolutely uniform inking of the type. The ink may be changed at any time without cleaning the type, and there is no danger of the paper being soiled by an excess of ink. The keyboard may be altered whenever desired, so that an operator accustomed to a certain arrangement of the keys may adjust the typewriter in a few moments. The absence of levers and springs reduces the risk of a breakdown. The compressed air which operates the machine is generated by a small electric motor using a few cents' worth of current per day. If desired, the compressed air may be supplied by a water motor, or any other form of power may be used.

Combined with this typewriter is an automatic duplicating apparatus, producing a perforated pattern on a paper sheet, as seen in one of the illustrations. This sheet is perforated while the type wheel is operated in the ordinary way. After the tape has been prepared it is arranged to travel over the keyboard, and the perforations will cause the copy to be reproduced by the machine. By this arrangement any number of copies of the same letter may be reproduced.



THE MACHINE OPERATED BY A PERFORATED SHEET.

A NEW METHOD OF PLATING METALS WITH TIN, ZINC, AND LEAD.

Various processes are employed for coating iron and other metals with tin, zinc, and lead. In the "dry" process the objects, after they have been thoroughly cleaned with acids and by mechanical means, are immersed in a bath of molten tin, zinc, or lead. In the "wet" or galvanic process metallic tin and zinc are deposited electrolytically from solutions of salts of those metals. Heavy lead plate is sometimes made by rolling, or by pouring molten lead on iron plates.

All of these methods have serious defects. Both the "dry" and the "wet" processes necessitate the employment of vessels larger than the objects to be plated, and in the "dry" process the metal of the bath soon becomes contaminated with that of the object to an extent that renders it useless. Two of the most important qualities of plated ware, density and cohesion of the plating and firm adhesion to the base at every point, are frequently lacking in objects plated by dipping in fused metal. It often happens that small cracks, depressions, and imperfectly cleaned

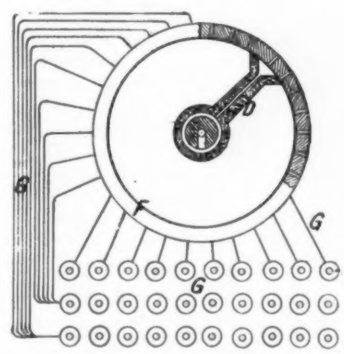


Fig. 3.—PLAN SHOWING THE VANE AND TUBE CONNECTIONS TO THE KEYBOARD.

spots are simply covered by a film of the plating metal which is not attached to the base and which soon scales off.

A new process of plating with lead, tin, zinc, and their alloys is being exploited by the Metal Paint Company (Metallanstrich-Syndikat) of Berlin. In this process the object is first thoroughly cleaned and the plating metal, finely pulverized and mixed with a suitable liquid, is applied to it with a brush, like paint. After the coating has dried it is fused by means of a gas flame or, in the case of small objects, by heating these in a furnace. After being cooled and mixed with water the plated objects are ready for use. In the operation of fusion the coating does not run off the sides or bottom of the object but adheres as firmly there as at the top. The temperature required varies from 365 to 465 deg. F.

In point of simplicity this process far surpasses all others. No baths, electric generators, or other cumbrous and expensive apparatus are required. The process can be applied anywhere and to objects of any size. It is peculiarly valuable for repairing and strengthening old plating, for the objects can be treated without moving them, taking them apart, or separating them from other parts of machines, etc. Hence all the expense of taking down, transportation and setting up is saved. New objects can be plated where they are made instead of being transported to a special plating establishment.

The cost of the process is not high, when the econo-

mies above mentioned are taken into account. The metal paint costs from $1.30 to $1.62 per pound, and one pound suffices to give a good, rust-proof coating to nearly 100 square feet of surface.

Tests made at the government testing station show that the plating is of uniform thickness and quality and is not affected by sudden cooling from 104 to —31 deg. F. Experiments in stretching, bending, and twisting tinned rods to the breaking point showed no scaling of the tin. The same negative result followed when tinned plates were pressed into concave molds.—Prometheus.

DREDGING ON THE PANAMA CANAL.*

A DESCRIPTION OF THE MACHINES USED.

BY F. B. MALTBY.

THE writer during a connection of about two and a half years with the Isthmian Canal Commission, most of which time was spent on the Isthmus, had charge of the design, construction, maintenance, and operation of the dredge plant employed, and intends to give a brief description of this machinery.

There are in use, or being built, four distinct types of dredges of entirely different characteristics: First, the old French ladder dredges; second, American dipper dredges; third, sea-going suction dredges; fourth, pipe-line suction dredges.

The so-called old French ladder dredges are those which the Americans fell heir to when the canal property was purchased from the French canal company. There were some 16 or 17 of these dredges, of the endless bucket type. They vary somewhat in detail, but are all of the same general construction. The digging apparatus consists of an endless chain of buckets holding about 14½ cubic feet each. This chain of buckets is carried by a box girder hinged at the top and of sufficient length to enable the dredge to work to a depth of about 30 feet. The buckets discharge into chutes leading over the side of the dredge and into barges alongside.

The chain of buckets is driven with a pair of steeple compound condensing engines, which are connected with the top tumbler wheel either through gearing or by friction wheels and large sprocket chains. Steam is supplied by Scotch marine boilers working under a pressure of 70 to 80 pounds. The hulls are of genuine wrought iron, not steel, and some of them were supplied originally with propelling machinery, but this has been taken off. The hauling and hoisting winches are simple but cumbersome and 1¼-inch chain is used for hoisting the ladder as well as for moving and maneuvering the dredge. No quarters were provided for the crews. These dredges were built either in Belgium or in Scotland. Some of them had been pretty well worn out and were of little value. Most of them were in a remarkably good state of preservation, although most of them had not been in use for at least eighteen years. The woodwork was entirely rotted away and required renewing throughout. The machinery had been carefully laid up and painted and had been well cared for. It required only cleaning up, packing of joints, and occasionally a rod needed truing up. The hulls, on account of being wrought iron, had corroded very little and were practically as good as new.

One of these old dredges was rebuilt at Cristobal and put into operation in May, 1905, and a second one was afterward rebuilt and repaired. The Panama Railroad Company was operating one at the Pacific terminus and it was turned over to the Canal Commission in June, 1905, and a second and third one have been rebuilt at that end.

These dredges of the non-propelling type have hulls of rectangular shape, about 114 feet long, 32 feet wide, and 12 feet deep. The engines operating the chain of buckets are of about 180 horse-power and are operated condensing. These dredges have no means for breaking up the material to be excavated other than the buckets themselves, and consequently their digging capacity or the ability to force the buckets into hard or compact material is not very great. For these reasons their capacity per day varies with the material to be excavated.

At La Boca, the Pacific terminus, there are two of these dredges in operation, working 24 hours per day and six days in the week. During the month of October, 1907, one of them removed 143,222 and the other one 143,885 cubic yards, an average of about 5,300 cubic yards per day. The maximum daily output in November was 6,907 yards and 7,556 yards respectively. The material handled is mud with a very considerable portion of sand, very easily excavated and handled with this type of dredge. During October, 1907, one of this same type of dredges removed 133,064 yards from the new channel in Limon Bay, or the Atlantic terminus. The reduced output below that of the dredges on the Pacific side is due to a greater seaway on the Atlantic side and also to the fact that the mud encountered is softer, and while it is easier to excavate, it is so soft that it will not pile up in the buckets and more or less is lost during the passage of the buckets through the water. The capacity of these dredges excavating in coral rock is reduced by about one-half. The material excavated is taken out to sea and dumped into deep water, the length of haul varying from two to four miles.

The dredges are served by self-propelling hopper bottom dump barges, which are also a part of the old French equipment that has been rebuilt. These barges have a hopper capacity of about 225 cubic yards of mud, measured in place. They have steel hulls about 145 feet long and are driven by twin screws and compound condensing engines. The hopper doors are operated by hand winches.

The operation of these old dredges has been rather surprising and very satisfactory. Their machinery, though cumbersome, is very simple, and very little trouble has been experienced through break-downs. The buckets have cast steel backs with ⅝ or ¾ steel fronts and bottoms riveted to them. They have an extra cutting tip or edge of 1-inch steel. The eyes in the links and bucket backs forming the chain are bushed with steel and have steel pins. These bushings and pins wear very rapidly, but their renewal is a very simple and inexpensive matter.

The bearings for the lower tumbler wheel, which are constantly working in sand and grit, also wear very rapidly; the journal boxes are of cast steel and made solid and without any provision for taking up wear. They are usually allowed to run till the boxes are nearly or quite worn through on the bottom.

The cost of handling material with these dredges, including the cost of operation, superintendence, all running repairs, and the cost of operating the barges, is between nine and ten cents per yard, though monthly costs have gone as low as five cents per yard. This cost does not include any proportion of first cost or depreciation or the first cost of extensive rebuilding.

It is evident that for excavating soft material to a moderate depth this type of dredge has certain advantages that are not appreciated in this country. They are very similar to the gold dredges that have been so extensively and successfully used throughout the West.

The second type of dredge in use is the dipper dredge. This is strictly an American type of dredge and was originated and has been used in this country to a greater extent than any other type in use. They can be briefly described as a steam shovel gone to sea, as they have all the characteristics of a steam shovel with the parts made usually much heavier and with a radius of action greater than a steam shovel. Three of this type of dredge have been built and are in operation on the canal, one on the Pacific side and two on the Atlantic side. Two of them were built by the Atlantic Gulf & Pacific Dredge Company, after designs made by A. S. Robinson, and the other one by the Featherstone Foundry and Machine Company. All three are of the same size and general construction. Steel has been used throughout, except in the spuds and dipper handle, which are of wood, the latter lined with steel angles and plates.

They have steel hulls 110 feet long, 37 feet wide, and 9½ feet deep, and are proportioned to excavate to a depth of 40 feet of water. They have dippers with a capacity of 5 cubic yards for excavating in sand or mud and have extra dippers of 3 cubic yards capacity and fitted with very heavy manganese steel teeth, to be used for continuous operation in rock.

The main engines operate the hoisting and backing drums and also the drums for handling the spuds, while the swinging is done with an independent engine. They are equipped with independent capstan engines and electric light plants. Steam is supplied by Scotch marine boilers at a working pressure of 150 pounds. The booms are of very heavy construction and about 52 feet long and are carried directly on the turntable without any overhead gallows frames. The spuds are of Oregon fir, 60 feet long. On two of the dredges these are single sticks 36 inches square, while on one of them the spuds are built up and are 42 inches square. The main hoisting lines are crucible steel cables leading direct to the dipper without the intervention of any purchase blocks, and all sheaves over which the line passes are 6 feet diameter. On two dredges two cables, each 1⅝ inches and laid side by side, are used, while on the other one a single cable 2¼ inch diameter is used.

The engines, gearing, and drums are proportioned to give a pull on the hoisting line of about 90,000 pounds. These dredges were built under general plans and specifications prepared by the writer, the details being left to the builders.

The principal advantage of this type of dredge lies in its ability to dig in hard material. It has been found quite possible to excavate coral rock without blasting, though the progress of the work is expedited by a small amount of shooting to loosen up the ledges and to permit the dipper to get a better hold on the rock. A somewhat smaller crew is required than on a ladder dredge, though the operator must be a much higher paid man, as the capacity of the machine in any given material depends almost entirely on the ability of the operator to keep it in constant and rapid operation.

Owing to some mechanical defects the operation of these dredges has not been as entirely satisfactory as was hoped, though I understand that these have been remedied to a very large extent. They cost about $102,000 apiece delivered on the Isthmus. During twenty days in the month of October, 1907, one of these dredges removed 70,000 cubic yards from the channel at the Pacific terminus, while the maximum daily output in November was 4,456 cubic yards.

The third type of dredge, and possibly the most important, owing to their size and cost, in use on the canal is the sea-going suction dredge. Two of this type have been built, one for each terminus, and one of them has been in operation at Colon since September, 1907. The second one, the "Culebra," reached La Boca under her own steam December 28, 1907, after a voyage of about 12,000 miles, much of it through heavy weather.

These dredges are designed to operate in the harbor entrances to the canal and are therefore built self-contained and are able to work in a considerable seaway. In general design they are very similar to the dredges "Manhattan" and "Atlantic," used in excavating the new Ambrose channel to New York harbor, and to the dredge "Delaware," in use in the Delaware River. They differ from these dredges in the detail of their dredging machinery and also in their equipment and arrangement of quarters.

Their hulls are of steel, 274 feet long between perpendiculars and 288 feet long over all, with molded beam of 47½ feet and depth of 25 feet. The hull framing is made in accordance with the rules of the American Bureau of Shipping for vessels of class A1. They have twin screws and are propelled by compound condensing engines 22 x 44 x 30-inch stroke.

The dredging machinery consists of two 20-inch single suction centrifugal pumps direct connected to compound condensing engines running at from 160 to 170 revolutions per minute, and at these speeds developing from 440 to 460 I.H.P.

The centrifugal pumps are located on each side of the ship a little aft of amidships. They have inclosed cast-steel runners about 72 inches diameter with six blades about 19 inches wide. The suction from each pump passes through the side of the ship a little below the loaded waterline and is joined to the suction pipe through a swivel elbow. The suction pipe is 20¼ inches inside diameter, ⅝ inch thick, and the sections are joined together by forged steel flanges welded onto the pipe. These flanges and the welded point have a greater strength than the pipe itself. The suction pipe is about 63 feet long over the suction shoe and the dredge can excavate to a depth of 40 feet of water. The pumps discharge into sand bins having a nominal capacity of about 2,000 yards. Steam is supplied by four Scotch marine boilers 14 feet diameter, 12 feet long, under a working pressure of 150 pounds.

The dredges are equipped with the usual condensers, pumps, and auxiliary machinery, and in addition have electric lights, evaporators, and a complete ice-making and refrigerating plant.

* From a paper read before the Engineers' Club of Philadelphia.

The dredges are entirely self-contained and are able to operate for a week or more with the coal and stores which they will carry.

Quarters are provided for a crew of about 57 men. The details of the dredging machinery, sand-bins, and arrangement of quarters, etc., were designed by the writer, while the general construction follows that of the dredges previously mentioned. They were built by the Maryland Steel Company at Sparrows Point, Md., and cost about $724,000 for the two.

The operation of the one now in commission has been most satisfactory, and there is every reason to believe that the second one will be equally as successful. On their tests they handled from 1,600 to 1,700 yards of sand and mud per hour.

The centrifugal sand pumps carried a vacuum on their suction side of from 26 to 28 inches. Their nominal capacity is about 2,000 yards per hour in clean sand or sand with only a small portion of mud.

The trip from Sparrows Point to Colon, a distance of 1,906 miles, was made in eight days and nine hours, including about half a day that she was hove to on account of a storm, or an average of 9½ knots per hour.

The dredge is operated for 24 hours per day for five and a half days per week, Saturday afternoon being used for coaling and taking aboard stores.

During the month of September, with a green crew and new machinery, 266,000 yards measured in place was excavated in the harbor of Colon; in October 273,-500 yards, and in November 304,000 yards.

The material is mud and does not readily settle in the bins, though it is readily excavated. By actual measurement it has been found that the pumps have handled as high as 87 per cent of solid material. The length of haul to the dumping ground is two to three miles. In commenting on the work of the dredge during September the Canal Record estimated that the excavation and disposition of the same amount of material from Culebra cut would have required the work of 14 steam shovels, 30 locomotives and work trains, and about 1,500 men. The crew of the dredge consists of 57 men.

The fourth type of dredge to be used in the canal is the pipe line suction dredge, or a suction dredge which deposits on shore, through a pipe line, the excavated material. The French company had several small dredges of this type, used for rehandling material, but they were never very successful in operation on account of the design of the pumps.

These pumps had suction and discharge pipes 16 inches diameter. The pump runner was about 24 inches diameter and had blades about 4 inches wide. These proportions will perhaps be better appreciated by comparing them with a pump for the same sized discharge pipe which was put on one of these dredges which had a runner 69 inches diameter with blades 11 inches wide inside the shroud.

One of these small dredges was rebuilt and a pump of the size just mentioned put on it. This dredge has been used in filling material into the low ground adjacent to Colon and in opening a channel in the old canal between Cristobal and Gatun, portions of which had filled up. The material from the channel was pumped ashore.

It is proposed to build the great Gatun dam by the hydraulic method or by pumping the material into place. The hydraulic method of dam construction is not new and has been extensively used in the West, but usually in localities where flowing water with a source at sufficient elevation is available for transporting the material. It should, however, make no difference in the success of construction of this nature whether the water is secured from mountains under a sufficient head to give the necessary velocity for transportation or this velocity is given by pumps. For this purpose two dredges are being built, which will first borrow as much material as can be had within reasonable distance of the dam, and will then re-handle and pump into the dam material excavated from the canal and brought to the site in dump barges.

These dredges are of steel, 135 feet long by 36 feet wide and 9 feet deep. They have a single 20-inch pump with double suction, driven by a pair of tandem compound condensing engines developing about 450 I.H.P. The suction pipe is provided with a cutter driven by an independent engine. The cutter and supporting frame are very heavily built and braced and designed for excavating very stiff clay. The discharge pipe is carried on floating pontoons to the shore line and from there to the point of discharge is laid on the ground.

It is not expected that it will be possible or advisable to pump material into the dam and up to the full height with a single pump. It has been found that about 75 feet head against a sand pump is about the economic limit, as beyond that the necessary peripheral velocity of the pump runner becomes so high that the wear is abnormal. By "head" is meant the total head against which the pump is operating, and will consist of friction in the pipe, velocity head, and the actual lift or static head.

When the head has reached the maximum economic limit it is proposed to use a relay pump. This will be a pump similar to the one on the dredge, but motor driven, and will thus not require any steam plant or foundation, and but little attendance. It will be placed at the end of the discharge pipe, which will lead directly into the suction side of the pump. Its discharge pipe can be extended till the head on the second pump has reached the same limit, when another pump can be added, and this repeated as often as necessary.

It is, however, improbable that more than two pumps on one line will be needed. These dredges have not been completed and are not in operation. Two of them are also being built for the construction of the dams at the Pacific end of the canal, as proposed by the Board of Consulting Engineers. The Canal Commission has just recommended the construction of locks at Miraflores instead of La Boca, which will obviate the necessity of dams near La Boca, but will necessitate the excavation of several miles of sea-level canal, for which work these dredges are admirably suited.

As tending to show the relative capacity of the dredging plant I have described, I will refer to the amount of excavation during the month of November, 1907. During this period the three ladder dredges, three dipper dredges, and one sea-going suction dredge excavated and removed 792,000 yards, while the total amount removed by steam shovels from the Culebra division was 788,000 yards, or the seven dredges removed 4,000 yards more than 42 shovels. Of the total amount dredged, 304,000 yards was taken out by the dredge "Ancon," which is at the rate of nearly 600 yards per hour for every working hour she was in commission during the month. The average amount excavated per day of eight hours per shovel is 784 yards, or 98 yards per hour.

It is realized that it would be impossible for the dredges to do the work performed by the steam shovels, but it is equally true that the steam shovels cannot do dredging work.

There is no desire to detract in any way from the work of the steam shovels, but I wish to emphasize the fact that they constitute only a part of the equipment for excavating the canal.

WHY CONCRETE SHOULD BE WATERPROOFED.

The fact that ordinary concrete is very porous and permeable has been one of the leading checks in its rapid development. Volumes have been written on how the ingredients might be mixed to produce a watertight concrete, but we might as well seek to solve the problem of perpetual motion as to try to mix cement, sand, and stone so as not to absorb water, says Myron H. Lewis, C.E., in a recent issue of Waterproofing. All the experiments that have been made and all the papers that have been written have only served to emphasize the fact that ordinary concrete is porous, and when dry will drink in water with avidity. And why should it not do so? Can ever-changing ingredients be so proportioned that every minute void in the hardened mass is filled?—so that the concrete becomes a solid, impervious body? No; in the act of mixing, enough air clings to the materials to render the mass full of innumerable minute blow holes; minute to us but not so to the still finer, freely moving molecules of water, which, with infinite patience, look for an opportunity to move and do so, if the movement is in the slightest degree possible. If we could examine a section of concrete under a powerful microscope, it would appear to us like an immense sieve through which fine particles of water flow without hindrance.

We have seen water rise up through concrete walls for many feet, and it will rise until the weight of the water absorbed is equal to the attracting force.

We have often heard the statement made that concrete is water-tight, and frequently it comes from those who should know better. It is often stated that if concrete is mixed rich, and mixed wet, impermeability can be secured. Both of these statements are against the very logic of things. Mixing rich may impose some greater barriers to the passage of water; mixing wet may minimize the formation of blowholes by displacing much of the extrained air, but neither mixing rich nor mixing wet destroys the "capillary positive" property of the concrete mass. Its absorptive capacity may have been decreased, but its attraction for moisture has not been eliminated; thus the water tightness secured by rich and wet mixtures, however theoretically correct the proportions might be, is one of degree only, a degree sometimes approaching ideal but never reaching it. We cannot expect that a mixture made of cement and stone, each of which is in itself "capillary positive" or water attracting, can become absolutely proof against the passage of water by the mere act of mixing, unless, indeed, the operation had produced some phenomenal change in the very nature of the constituent materials. A mixture may be produced which is sufficiently close-grained to prevent the free transmission of water, prevent it sufficiently, in fact, to be all that is required in many forms of construction work. But where water absorption, besides water penetration, is to be prevented, no degree of mixing, no richness of mixture, will altogether answer the purpose; and yet in many of the forms in which concrete enters our modern buildings, it is resistance to water absorption that is required. Not merely water-tightness in the ordinary sense of the word, but resistance to the ceaseless endeavors of atmospheric moisture to find its way by capillarity through porous bodies. Some counteracting influence to this tendency of ordinary concrete to take up water by capillarity is, therefore, what is required, particularly in superstructural work.

It is true that concrete exposed to the free passage of water becomes after a time so clogged up by the fine silt present in the water that the permeability is greatly reduced; and Hagloch states that concrete block buildings exposed to the weather become water-tight in from three to twelve years, a fact which we must likewise ascribe to the clogging of the surface of the blocks by atmospheric dust deposited by rain, and which remains after evaporation.

Modern engineering or architectural practice should certainly not sanction a practice of waiting for the erratic and uncertain hand of time to secure water-tightness in concrete structures, and in the meantime to incur the annoying consequences that always accompany damp and leaky structures; and yet this is precisely what is being done in numberless instances by those who refuse to realize the importance of water-tightness in concrete work, or, while realizing it, are willing, through motives of false economy, to gamble with the future—nearly always at their loss.

The number of mistakes made by inadequate provision for waterproofing, and their costly consequences, running into millions of dollars, should serve as object lessons to those who have the design of concrete work in hand; object lessons which should serve to prevent repetition of mistakes made by less fortunate predecessors.

The subject of waterproofing concrete could not be justly treated without some mention of the difficulties to be apprehended by the failure to obtain water-tightness; difficulties which would seem to be obvious, but which, as we have already said, are so often lost sight of.

Concrete blocks are usually made very porous, and have an intense affinity for water. Buildings therefore built of untreated blocks are damp, cheerless, and cold, and bring with them the discomforts and dangers to health that usually accompany damp buildings. Perhaps the only exception is the independent two-wall system with unbroken air spaces throughout. Plaster can never be safely applied upon their inner surface without furring and lathing. Furthermore, the faces of the blocks are soon disfigured by the deposit of soluble salts of efflorescence washed out from the cement. Some method of protecting the interior plaster from destruction by dampness becomes a necessity, otherwise the structure, instead of being a pleasure to the owner, becomes an eyesore. In addition to the unsanitary condition and the accompanying disfigurement, there is also the question of durability to consider. Any material that absorbs large quantities of water is subject to enormous strains when freezing occurs, and is liable to be destroyed in the course of years.

In reinforced concrete work, particularly in the superstructure of buildings, all the above objectionable conditions resulting from lack of water-tightness apply equally, and in addition we have the danger of corrosion of the imbedded metal. Ample experience seems to indicate that metal thoroughly incased in concrete is protected from corrosion by the latter, provided that water in sufficient quantity cannot work its way to the metal and begin corrosion. Concrete work, however, is subject to checking and cracking from a multitude of uncontrollable causes, and should through any such means rusting be made possible, its progress cannot very well be checked. Rusting, which is the conversion of the metal into its oxide, is accompanied by expansion, which produces enormous strains in the incasing material, strains akin to that produced by water in freezing.

K. V. Charitschkow has obtained by the destructive distillation of a Russian asphaltum, a liquid product which on distillation, yielded up to 150 deg. C. a fraction similar to Grosny benzine. From a Roumanian asphaltum, which on extraction in a Soxhlet apparatus, yielded 48.98 per cent of bitumen, there were obtained on destructive distillation: water, 4.76; oil, 4.44; and residue, 79.20 per cent. The residue contained 36.06 per cent of carbon and 63.94 per cent of mineral matter. On distillation the oil yielded 13.20 per cent up to 200 deg. C. and 68.37 per cent of residue similar to that obtained from petroleum. In the experimenter's opinion both asphaltum and crude petroleum are formed directly from acetylene and hydrogen.

AN AUTOMOBILE ROAD ROLLER.

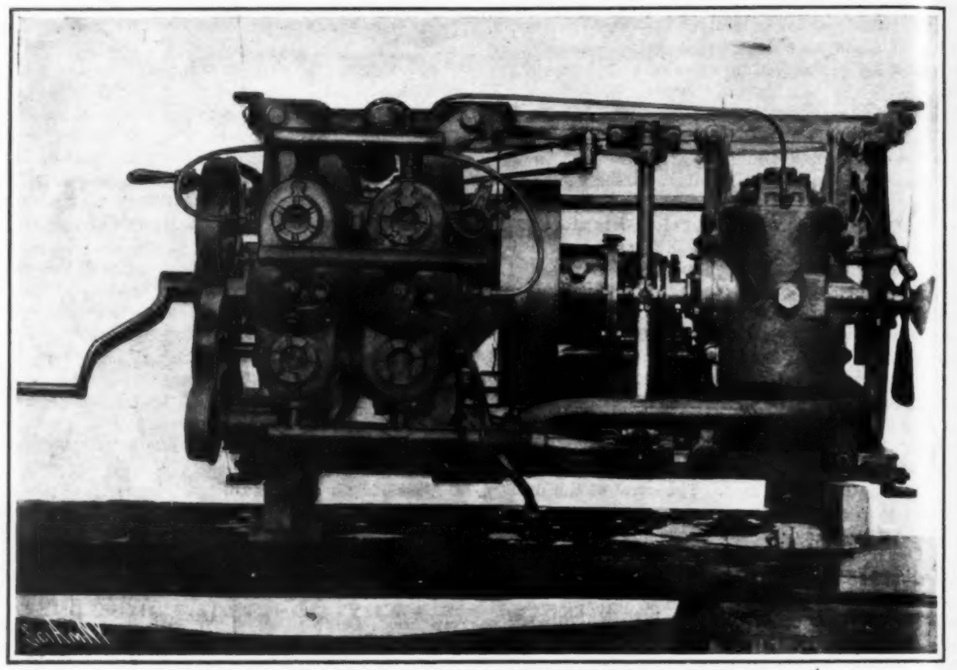
A NEW FRENCH TYPE.

BY OUR PARIS CORRESPONDENT.

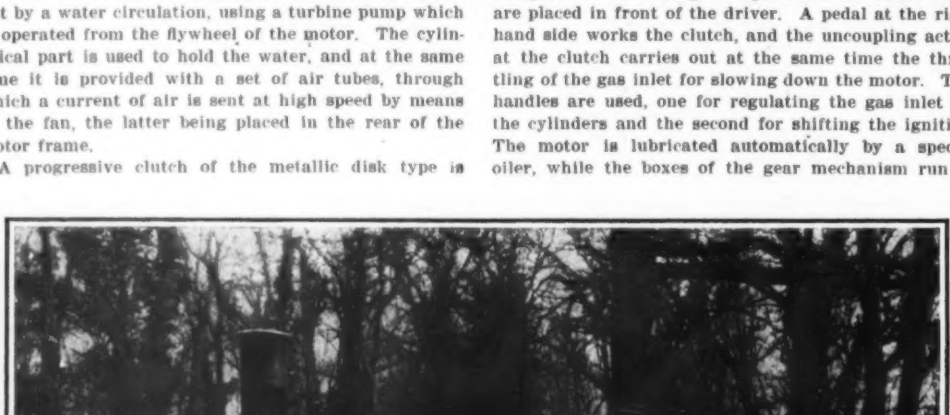
THE new automobile road roller illustrated herewith is one of the most improved types constructed in France. Aside from the advantages which are given by the mechanical design, it can be taken apart readily for transportation, each of the parts being of comparatively light weight, so that it can be easily brought to certain regions where the entire apparatus could not enter by the road and quickly be reassembled. The present apparatus is made up of three principal parts, the main framework or chassis, the rollers, and the motor with its accessories. The chassis is built of sheet steel and serves to connect the front or directing axle with the rear axle, the latter being driven by the motor. In the front part the chassis has the form of a cylindrical body which serves as a reservoir for water used in the cooling apparatus. The front roller is mounted in a fork which is pivoted in a head at the forward end of the chassis. In the rear, the chassis is enlarged, and takes the form of a rectangular frame which is fixed to the cylindrical part. Underneath the platform are fixed the bearings for the rear rollers, while the rear of the platform serves for the driver's post. The motor is mounted, as will be observed, in the central part of the machine. The front roller consists of a pair of rollers placed side by side. The rear rollers are connected to the driving axle, on which they are mounted by a ratchet mechanism. The gasoline motor, along with the carbureter and magneto, the speed-changing box and the levers which belong to it, the air fan of the motor, the clutch lever, etc., is quite independent of the chassis, and can be removed without interfering with the operation of the mechanical parts.

The motor is of the two-cylinder type, having the two cylinders mounted separately on the crank-case. The motor is designed for running at a moderate speed, so as to avoid having too much gear reduction. Both the inlet and the exhaust valves are cam-operated. The carbureter is of the automatic float-feed type and is provided with a hot-water circulation from the water jackets in order to secure the best gas mixture at all the speeds of the motor and regardless of the temperature of the air. Magneto ignition is employed. The exhaust gas is taken off by means of piping which passes underneath the cylindrical part and outside the latter, reaching the smokestack which is mounted on the front of the apparatus. A special arrangement on the motor is used for running with free exhaust when such is desired. Cooling of the motor is carried out by a water circulation, using a turbine pump which is operated from the flywheel of the motor. The cylindrical part is used to hold the water, and at the same time it is provided with a set of air tubes, through which a current of air is sent at high speed by means of the fan, the latter being placed in the rear of the motor frame.

A progressive clutch of the metallic disk type is used here, with steel and brass disks, inclosed in a tight case and working in oil. The clutch spring is placed on the outside, where its tension is regulated by a nut, and the reaction of the spring is taken by a thrust ball bearing. The speed-changing mechanism is composed of straight and bevel gearing which can be shifted by means of a lever so as to provide for the different speeds, of which there are two, 2 and 3 miles an hour respectively, with reversing mechanism. The rear axle is driven from the speed mechanism by means of worm gearing. Ball bearings are used throughout. There are two brakes mounted on the machine which are applied on the rear rollers, using cast-iron brake shoes. A set of levers is used to operate the different movements. There are two levers designed for the change of speed and direction which are placed in front of the driver. A pedal at the right hand side works the clutch, and the uncoupling action at the clutch carries out at the same time the throttling of the gas inlet for slowing down the motor. Two handles are used, one for regulating the gas inlet for the cylinders and the second for shifting the ignition. The motor is lubricated automatically by a special oiler, while the boxes of the gear mechanism run in lubricating grease. The axle boxes are provided with separate oilers.



REMOVABLE ENGINE OF THE AUTOMOBILE ROAD ROLLER.



AN AUTOMOBILE ROAD ROLLER OF IMPROVED TYPE.

OLD AND NEW METHODS OF TEMPERING STEEL.

M. LÉON GUILLET, in the course of his lectures on metallurgy at the Conservatoire des Arts et Métiers, has taken occasion to show the influence of scientific researches on the development of metallurgy. He observes that few subjects have stimulated invention as greatly as the quest for the best process of tempering metals. Empirical formulas have been given from the remotest antiquity. Pliny has many references to this subject. He even indicates the effect of the tempering bath, asserts that the waters of certain streams are more efficacious than those of others, and that oil should be employed in many cases. Each epoch saw the appearance of new and strange methods of tempering, and though Shakespeare affirms that Othello's sword was tempered in the frozen brook, a certain number of steelmakers at least are by no means content with baths of such simplicity. For example, see these formulas quoted by Roberts Austen:

"Boil some snails in rainwater collected in the first two months in the year, bring your iron to a red heat, quench it suddenly in this bath, and it will become as hard as steel. You can do the same thing with the blood of a man thirty years old, of a sanguine temperament and a gay and agreeable disposition, the blood having been drawn in the middle of May." This is rather ridiculous; nevertheless, the belief in solutions of this character has persisted to our day, for I find in a book printed in 1810, the advice to take the root of the blue lily and infuse it in wine, or to take the juice of the common bean for a tempering bath for the purpose of making iron or steel as soft as lead.

The true theory of tempering has only lately been known. After the researches of Tschernoff in 1868 and of Osmond in 1885, it was known that the necessary and sufficient condition for tempering steel is to cool it after it has been heated to a temperature between 800 and 900 deg. C. (1,472 and 1,652 deg. F.), according to the composition of the steel employed.

Up to 1890 carbon steel containing from 0.7 to 1.2 per cent of carbon was employed almost exclusively. When such steel, after being tempered, is heated to 700 deg. C. (1,292 deg. F.) it loses its hardness or temper. When a tool formed of such steel is used, it is necessary to take care to avoid heating by sprinkling it freely with oil, soap suds, or water.

Mushet discovered the self-tempering steels of which cutting tools are now made. These steels are formed by the addition of tungsten and manganese. They have the property of becoming tempered without the use of water, by cooling in the air. Although they were discovered in 1860, they were not used in industrial practice until 1890.

Brustlein introduced chrome steel, which when tempered in a liquid bath acquires extraordinary hardness. But all these steels lose their temper upon being raised to a dull red heat, hence in workshops the speed of cutting machines and the depth of the cut are limited by the necessity of keeping the tool comparatively cool.

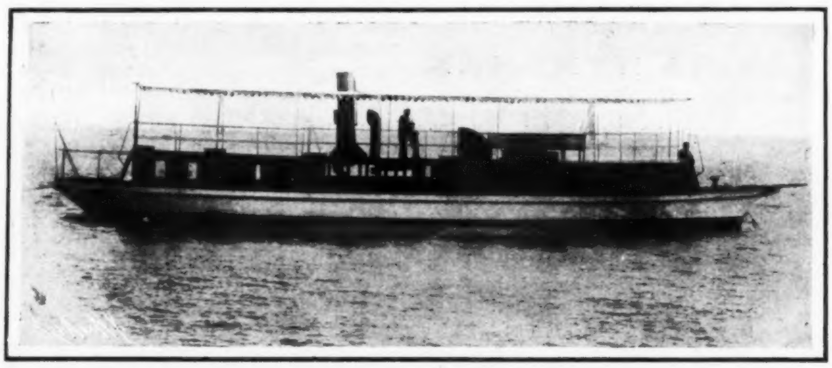
Happily, as a result of the methodical researches of White and Taylor, we possess to-day a number of rapid-cutting steels which were shown for the first time at the Paris Exposition in 1900. They are characterized by a high percentage of chromium and tungsten, and can be heated to a dark red heat without injuring their temper. They permit the employment of extraordinary speed and depth of cut. They produce very large shavings which come from the machine red hot, which accounts for their blue color after cooling. A large American factory had decided to double its plant, but in consequence of the discovery of the rapid-cutting steel, it was found possible to double the output of the existing plant instead.

A 100-HORSE-POWER MOTOR YACHT.

A GASOLINE CRUISING BOAT.

BY OUR ENGLISH CORRESPONDENT.

THE perfection of the small internal-combustion motor, and its ready adaptability and facility in handling, combined with high efficiency and reliability, has resulted in this form of motive power being utilized in vessels of more importance and larger dimensions than mere racing shells. Recently a large yacht, the "Svietlana," has been constructed by Messrs. Thornycroft & Co., the well-known English shipbuilders, for a Russian gentleman whose idea is to employ the vessel for cruising purposes upon the rivers of Central Russia, the broad waterways being eminently adapted to this class of traffic. Instead of using steam this craft is equipped with internal-combustion engines developing 100 horse-power, the advantage of the latter as compared with the former system being a reduction in the crew to one or two men. Hitherto the utilization of such motive power has been rather in the form of an auxiliary, but in this particular instance the boat is entirely dependent upon its motors.



THE "SVIETLANA," A 100-HORSE-POWER MOTOR YACHT.

The "Svietlana" measures 78 feet in length over deck, while its length on the water line is 70 feet. The beam is 13 feet, depth 4 feet 9 inches, draft loaded (on trial) 1 foot 9 inches. The hull is built of Siemens-Martin steel plate galvanized. A schooner bow is fitted with an attractively carved figure head and bowsprit, which gives the yacht a smart appearance, while the stern is elliptical. A promenade deck extends for a length of about 56 feet over the cabins, on which are placed the steering wheel, engine room telegraph, and some sparred seats. This deck is covered by an awning supported by brass stanchions, and a large open space is provided, broken only by the small funnel for carrying off the exhaust gases, and the engine room ventilating cowl. The main deck extends the full length of the vessel and affords access to the cabins and staterooms, which extend longitudinally along the center of the ship fore and aft the motor room. The internal accommodation is ample and conveniently arranged. There is a commodious saloon in the fore part of the vessel furnished with lounges, sideboards, dining table, and other appointments. Aft of this saloon are two staterooms with sleeping berth, lavatory, and the usual fittings. The pantry, fully equipped, is on the port side, while on the starboard side is a commodious bath room, etc. Forward of the motor room bulkhead is the kitchen and cooking galley, while aft of the engine room is a second saloon appointed in a style similar to that forward and entered from a companion on the port side. The crew's quarters are right at the stern and are roomy and well lighted and ventilated.

The motor machinery is divided into two units, comprising Thornycroft four-cylinder vertical water-cooled motors with cylinders of 6-inch bore by 8-inch stroke, and each developing 50 horse-power. The power is transmitted to twin propellers working in tunnels on the Thornycroft system to insure proper immersion and to protect the screws from damage by floating debris.

Owing to the difficulty of securing such a volatile spirit as gasoline in many parts of Russia, the engines are designed to run primarily on kerosene, though the former fuel may be used if desired, it only being necessary to operate the lever controlling the special type of change-over throttle valve fitted for this purpose. By means of this device, when the motors are running on gasoline, as when first starting up, the gasoline vaporizer is in connection with the inlet pipe of the motor, while when on kerosene the vaporizer for the heavier fuel is brought into action. The exhaust in either case is carried around the vaporizer before passing to the muffler, so that when it is desired to change from the lighter to the denser fuel it may be effected instantly. The muffler is fitted in the funnel amidships, whence the gases escape into the air, though they serve to actuate the three-toned signal siren when desired.

In the builder's trials the vessel proved very speedy for a craft of this type, a mean speed of 12.5 miles per hour being attained in the Solent. In view of the ample beam of the yacht and the load carried such a result may be considered highly satisfactory.

THE DISTRIBUTION OF COAL AND THE RATE OF ITS CONSUMPTION.

NOT only has America the largest store of coal in the world, but it has the further advantage that the amount that has been mined is comparatively small. It is only of late years that the output of coal has been in proportion to the magnitude of her coalfields, but in the last year of the past century she deprived England of her position as the world's greatest producer, and now is easily first, raising at least a third more than is done in the United Kingdom.

Leaving America to look after her own vast interests, let us see how the ratio between capital and expenditure compares for the chief European powers, taking them in order of coal production:

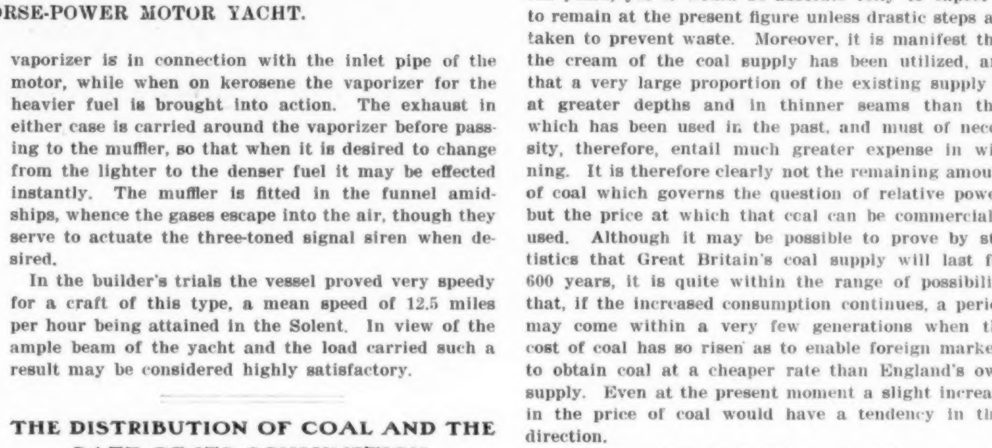
	Production per annum.	Total Coal, Millions of Tons.
Great Britain	236,130,000	140,000
Germany	119,350,000	150,000
France	34,780,000	17,000
Belgium	21,500,000	16,000
Russia	17,120,000	20,000

Such figures can be only the merest approximation, but if they are of any value at all they mean that England is the spendthrift of Europe, and that her supremacy is at the cost of such capital expenditure that, unless she take the position seriously and do everything in her power to retrench by economizing much of the fuel now wasted, it is evident that before many generations have passed she must lose her priority among the European nations.

At the present rate of use English coalfields would be exhausted in a little over 600 years, which seems at first sight to be a fairly comfortable reflection, but it is clear that the use of coal will go on increasing until shortage and consequent rise in price checks the demand. Although the demand may not be in the enormous proportion that has characterized the past ten years, yet it would be absolute folly to expect it to remain at the present figure unless drastic steps are taken to prevent waste. Moreover, it is manifest that the cream of the coal supply has been utilized, and that a very large proportion of the existing supply is at greater depths and in thinner seams than that which has been used in the past, and must of necessity, therefore, entail much greater expense in winning. It is therefore clearly not the remaining amount of coal which governs the question of relative power, but the price at which that coal can be commercially used. Although it may be possible to prove by statistics that Great Britain's coal supply will last for 600 years, it is quite within the range of possibility that, if the increased consumption continues, a period may come within a very few generations when the cost of coal has so risen as to enable foreign markets to obtain coal at a cheaper rate than England's own supply. Even at the present moment a slight increase in the price of coal would have a tendency in this direction.

It is clear that Great Britain is living upon its capital, and under the existing conditions increase in commercial activity really tends toward the destruction of the main factor in English well-being. Although the same conditions exist in other countries to a certain degree, there is not the slightest doubt that English trade rivals are taking advantage of all possible economies to a much greater extent than the British are.

At the present time Germany seems to be the popular bugbear in the public mind, and for that reason one feels almost ashamed to say anything that might be construed into an attempt to foster that feeling, but a little consideration must show that Germans



ONE OF THE TWO 50-HORSE-POWER MOTORS OF THE "SVIETLANA."

are undoubtedly England's great trade rivals, and that England is playing into their hands in a way that is perfectly indefensible. Germany's present store of unwon coal is now practically the same as Great Britain's, but the amount they raise is only half, although their annual rate of increase has been much greater, still, at the present rate of supply, if it remains constant, the German coal will last for double the time of the British, that is, if the life of England's coal supply is 600 years, theirs will be 1,200. The conditions existing in Germany are all of a character to sap slowly but surely British strength and resources.

At the present day there are collieries in England, one alone of which brings to the surface over a million tons per annum of some of the best coal in the country, not one ton of which finds its way into the English market, but is all exported. This coal is able to compete with German coal in price right up the Rhine close to the principal German coalfields and as far as Mayence. The total amount of coal exported from Great Britain is over 20 per cent of the coal raised, and supposing that the life of England's coal supply were 600 years this item alone means 120 years. It must be remembered, however, that a good deal of the exported coal is for foreign coaling stations, and is used by British ships, but something should certainly be done to prevent the depletion of the coal supplies of the kingdom to supply trade rivals.

It would be madness to advocate anything which would check or cripple commerce in any way at the present time, but it must be clear to everyone that in the interests, not only of the country, but of each individual in it, everything should be done which could tend to economy in the use of coal. If the individual units in the empire would only realize that by slightly altering their methods of fuel consumption, they could not only obtain the same manufacturing results, but do so at greatly reduced cost, and at the same time purify the atmosphere, a time would soon come when the health and wealth of the country would benefit.

The Royal Commission on Coal Supplies of 1905 compiled statistics as to the proportion of the coal raised that was utilized for various purposes, which may be represented in percentages, as follows:

	Per cent.
Factories	22.97
Domestic	13.87
Iron and steel manufacture	12.17
Mines	7.80
Gas works	6.50
Railways	5.53
Potteries, brick works, glass works, and chemical works	2.16
Metal and minerals	.43
Coasting steamers	.87
Steamers over seas	7.25
Exported	20.35

—Prof. Vivian B. Lewes in the Journal of the Society of Arts.

THE LIQUEFYING OF HELIUM.

PROF. ONNES' REMARKABLE ACHIEVEMENT.

BY FRANCIS HYNDMAN.

On July 10 Prof. H. Kamerlingh Onnes, of Leyden University, and his assistants had the satisfaction of seeing a considerable volume of liquid helium remain for some hours. This conquest over the last and most refractory gas was made known within a day or two, but few details were given until the appearance of the official publication, from which this note is taken.

Prof. Onnes points out that the first step necessary was the determination of isothermals of helium, and in particular of those at temperatures obtainable only with liquid hydrogen. From these the a and b of Van der Waals's theory can be obtained, and the Boyle point, i. e., the temperature at which the minimum of pv occurs with very small densities, be found. This point also occurs at one-half the absolute temperature of the Joule-Thomson inversion point at low densities. With these data he was able to apply a theorem developed in 1896 from an earlier and more general theorem of 1881 during the endeavor to liquefy hydrogen statically. The theorem shows that the Boyle point of helium lies somewhat above the lowest temperatures obtainable with hydrogen, and hence that a regenerative process, as applied by Linde and Hampson to air and by Dewar to hydrogen, could be effective with helium.

Ever since 1883, when Prof. Onnes commenced his work at Leyden, there has been continuous effort to reach the nadir of temperature. It has taken some years to get the necessary data for helium together. In 1905 much help was obtained from the Commercial Intelligence Office at Amsterdam under the direction of Mr. O. Kamerlingh Onnes, who obtained a sufficiency of the monazite sand, used for the preparation of helium, at a cheap rate. The helium is obtained from this by heat, and is then most carefully purified. The first isotherm determinations on helium were made in 1907. It was owing to Olszewski's and Dewar's failures that various methods, such as the helium motor with vacuum glasses as cylinder and piston, were considered, but these were abandoned, owing to the results of the isotherm determinations, which pointed to a critical temperature of about 5 deg. to 6 deg. K. This result was in better agreement with Dewar's estimate of 8 deg. K. obtained from experiments of absorption by charcoal than with Olszewski's of below 2 deg. K.

However, the conclusion from the isotherms was not quite decisive, as those at the lowest temperature indicated a lower critical temperature than those at higher temperatures, and this appeared to throw some doubt upon the strict applicability of the law of corresponding states to helium. At all events, just before the experiment was undertaken it was shown that the Boyle point, though below the boiling point of hydrogen, was somewhat above 15 deg. K., which is obtainable with liquid hydrogen under reduced pressure.

The time had hence arrived to reap the fruit of the many years of work devoted to building up the cryogenic laboratory for the use of prolonged accurate measurements in liquid gases, with all the circulations so arranged that the gases remain pure. This is particularly important in the hydrogen cycle, where 4 liters of liquid can be dealt with per hour and a supply can be obtained in a state of great purity and stored for use.

In the arrangement of the experiment constant use was made of the theory of Van der Waals. The apparatus was made as small as possible, but there was a practical limit which was fixed by its necessary relation to the other apparatus in use. To compress the helium the special mercury pump was used, which was completed in 1888, and was used to give baths of static oxygen in 1894. It compresses to 100 atmospheres, which, with the critical pressure below 5 atmospheres for helium, is a high reduced pressure. This pump circulates 1,400 liters per hour, which is sufficient with the dimensions of the apparatus taken, and has a capacity with connections of about 200 liters. For this experiment it was not possible to run the helium and hydrogen cycles at the same time, so that sufficient liquid hydrogen had to be made before the experiment on helium was commenced. However, now that the main difficulties are overcome, it will be possible to work the two cycles simultaneously.

In directing attention to Sir J. Dewar's work for this and similar researches Prof. Onnes points out especially the use he has made of the selective absorption of charcoal for gases in the purification of gases under pressure, and to the advantage of silvered vacuum glasses.

Such glasses are used at every stage of the work. For example, the liquid hydrogen is collected in an unsilvered glass placed in liquid air contained in a silvered glass with a strip of clear glass left to enable the interior to be seen. The liquid hydrogen is transferred by pressure through a fine tube into the experimental apparatus.

A detailed description is given in the paper of this apparatus, which is, however, simple enough in principle. The regenerator spiral, through which the compressed helium is expanded, is contained in the upper part of a vacuum glass also containing lower down the upper bulb of a helium thermometer. The helium glass is contained in a second, which is filled with liquid hydrogen and connected to the hydrogen circulation. This glass in turn is contained in another filled with liquid air, and this finally in one containing alcohol. All these glasses are unsilvered, so that a clear view is obtained of the central glass and its contents.

The day before the successful experiment, July 9, was devoted to the preparation of 75 liters of liquid air, and at 5:45 A.M. on July 10 the work was commenced to obtain the necessary liquid hydrogen. By 1:30 P.M. 20 liters were standing in the special vacuum glasses. Meanwhile the helium and hydrogen circulations were pumped free of air and washed through with their respective gases, and a start was made to cool the liquid-air glass. At 2:30 hydrogen cooled by liquid air was taken through the hydrogen glass, and by 3 P.M. the temperature was down to —180 deg. C. At 4:20 the helium circulation was started, liquid hydrogen was introduced into its glass, and the pressure lowered until at 5:20 P.M. it reached 6 cm., at which it was kept. Between 5:30 and 6:30 the pressure of helium in the spiral was gradually raised to 100 atmospheres. At 6:35, when the pressure was allowed to fall rapidly to 40 atmospheres, the helium thermometer indicated a temperature below that of the liquid hydrogen; nearly 6 deg. K. was read once. At this time the last reserve of liquid hydrogen was connected, and no liquid helium had been seen. A quicker expansion was allowed, and the temperature fell and constantly returned to the same temperature of less than 5 deg. K. It was as though the thermometer stood in liquid.

Somewhat later, at about 7:30, the surface was seen at the top of the vacuum glass. The liquid having been found under ordinary pressure there was no doubt that the critical pressure was more than 1 atmosphere. The surface was illuminated from below, and had the appearance of a liquid near the critical state in a Cagniard de la Tour tube, cutting the walls like knife-edges, though in this case the diameter was 5 centimeters. There was also a marked contrast between the helium and the hydrogen in the next outer tube. Some of the evaporated helium was now collected and used for a density determination giving 2.01. At 8:30 the pressure on the helium was reduced, and 2.3 centimeters was measured. The pumps, however, can give 2 millimeters, and it is quite possible that as little as 7 millimeters was reached, but no solid could be seen. At 9:40 only a few centimeters of liquid helium remained. Thus liquid helium, starting with an amount exceeding 60 centimeters, had been under observation for more than two hours.

All the evaporated helium was collected into three portions, which gave densities of 2.04, 1.99, and 2.02. As a further test of purity a special comparative spectroscopic investigation was made with known mixtures of hydrogen with helium, and it proved that not more than 0.008 per cent hydrogen was present. This high degree of purity is also confirmed by the easy working of all cocks, which would have been stopped by a very little frozen hydrogen, and also by the condition of the last remaining liquid. The thermometer was also controlled by a measurement of the boiling point of oxygen, which gave 89 deg. K. instead of 90 deg. K.

The properties found are as follows: A boiling point at 4.3 deg. K. on a constant volume helium thermometer with a pressure of 1 atmosphere at about 20 deg. K. Corrected to the absolute scale the best value would appear to be 4.5 deg. K. The triple point, if it exists, is certainly below 1 centimeter, perhaps below 7 millimeters, at which, by corresponding states, the temperature would be about 3 deg. K., and the liquid remains very mobile.

Liquid helium has a density of 0.15, which gives b a value of 0.00017, about twice that which has been assumed before from then known properties and used in calculations. From this, again, the critical pressure must be about 2 to 3 atmospheres, so that helium under 5,000 would correspond with carbon dioxide under 100,000 atmospheres. At the boiling point the ratio of vapor to liquid is 1 : 11, which indicates a critical temperature of not much more than 5 deg. K. and a critical pressure of about 2.3 atmospheres. Lastly, the value of a will be about 0.00005, the smallest value known, but a most interesting confirmation of Van der Waals's contention in 1873, that there must be some attraction between the molecules of all substances.—Nature.

Balenite.—This is a whalebone imitation mass made from 100 parts of caoutchouc, 20 parts of ruby shellac, 20 parts calcined magnesia, 25 parts of sulphur, 20 parts gold sulphur. The substances, pulverized as finely as possible, are mixed as intimately as can be, in a mixing drum or rubbing dish, and the mixture, under application of heat, incorporated with the caoutchouc. The plastic mass obtained in this manner, is either formed into slabs and this cut into strips of the desired thickness, or molded at once into strips. The final operation is always the burning of the mass; the higher the temperature is carried in burning, the harder the substance becomes, but the more it loses in elasticity.

THE SWASTIKA.*

THE HISTORY OF A POPULAR SYMBOL.

BY CHARLES DE WOLFE BROWER.

To archæologists and students of religion and art, the Swastika has been for many years a fascinating but tantalizing study. It is the theme of a no mean literature, its bibliography bearing the names of some of the world's best known scholars. The name and symbol are now becoming generally familiar because of the introduction everywhere for sale of all sorts of Swastika jewelry, and even table wear. One of the oldest symbols, its beginnings reaching to an antiquity long preceding history, its use continued to some degree through the ages, it has suddenly been given new life by this amulet-wearing fad.

The name Swastika, given this unique form of cross, may be called modern, since it is not the original name, and might be applied to any amulet. This name can be traced to about the fourth century B. C. There is general agreement that the word is Sanscrit, from *SU*, equal to the Greek *εv*, "well," and *AS*, "to be," form *asti*, "it is," with suffix *κα*, the whole popularly meaning "good luck."

This name is now accepted practically in all countries, though its use has been objected to as implying too strongly that India was the original home of the symbol. Doubtless the sign itself was in existence before the Sanskrit language. It is to be noticed that the name Swastika gives no light as to the original meaning of the symbol, but is only a designation appropriate to a late stage of its history. Swastika is given in a modern Sanskrit dictionary as "a mystical mark made on persons or things to denote good luck."

The wide distribution of the Swastika symbol, including almost every country, is a remarkable fact. As an antiquity it has been found in Japan, China, and Tibet, probably having been adopted in these countries with Buddhism from India, where it is quite frequent, especially associated with Buddhist objects. Persia affords examples, though it is said to be wanting among the more ancient remains. Dr. Henry Schliemann's discoveries of the Swastika at Old Troy, in the Third City, the city he considered the Homeric Troy, place it, at that point, at a period 1,200 or 1,300 years B. C. Most of the objects bearing the symbol were small whorls. The Swastika is found in the Caucasus, in Greece, and the adjacent islands as a mint mark, on vases and various sorts of prehistoric pottery, and in decorative work. In Italy it is believed that some of the earliest examples of the Swastika have been found on the hut-urns or pre-Etruscan cinerary urns. Early Etruscan vases, for which a date is claimed of from the twelfth century B. C. to 540 A. D., bear Swastikas. Hundreds of examples are found on Christian tombs in the Catacombs of Rome. In Austria, Germany, Switzerland, Scandinavia, in ancient mounds, on early art work, bronze spear points, and other objects of bronze and iron, the same symbol appears. France affords examples. In Great Britain it has been found on Celtic funeral urns, Roman votive altars, Christian sepulchers, and other objects. In Iceland, Coomassie, Africa (but only on some bronze ingots), in Central America, Mexico, and South America examples appear. In North America there are many interesting specimens found among the remains of the aboriginal Indians. Prof. Clarence B. Moore, of the Philadelphia Academy of Sciences, found them in the pre-Columbian mounds at Moundville, Ala., as recently as the spring of 1905. These mounds, belonging to the copper age, contained, among many other objects of value, sheet copper ornaments on which the Swastika occurs, with skeletons which have almost disappeared through age; a gorget with three circular lines surrounding a Swastika; also a pendant 6 inches long, bearing a Swastika with a triangle below it, and other ornaments. It is an interesting fact that thus far the Swastika has not been found in Babylonia, Assyria, Phœnicia, or Egypt as native objects, but only as introduced, for example, on vases from Cyprus and Greece.

The theory of the independent origin of the Swastika quite breaks down in the presence of the facts stated, and the interesting question of the relations and migrations of nations or persons comes to the front. A Tennessee shell mound ornament, bearing a Swastika, is said to duplicate another found in Sweden. It may be added that the very form itself of the cross, not easily made, is not one likely to have been invented by many and widely separated peoples. There is also what might be called the modern use of the Swastika, a survival representing another and possibly a degenerate stage in its history. It becomes an inheritance used in ignorance. In Turkey and Persia the design has been and is worked in rugs, and can be seen in many such in our own homes and shops. Mr. Perceval Landon, in his story of the recent English expedition, "The Opening of Tibet," says that the envoys from Lhasa to the English camp had saddle cloths of Swastika-patterned stuffs. "Invariably there will be found outside a house four things, among them the white and blue Swastika, surmounted by a rudely-drawn symbol of the sun and moon. This sign marks every main doorway in the country." It is used by some Buddhists as a sign of benediction. The Jains, an offshoot, claim to use it as a symbol of resignation, contentment under all circumstances, in keeping with the strict meaning of the name. The Navajo, Piña, Sac, and Apache Indians weave the sign in rugs and baskets, and some of them hammer it out of silver for the trade, as is also done in Mexico. The Kansas and Osage Indians are said to introduce the symbol on charts in mourning ceremonies. Work baskets made for women in Japan sometimes show the same. The appeal to its mystery, novelty, and to superstition is made to minister to its sale in many forms.

The question as to where the Swastika first originated is one impossible to answer at present. There are advocates of many places and times. It has been associated with the bronze age, making its way east and west with that age. Of course the Orient, and India especially, was formerly claimed as its birthplace. But many inconclusive arguments have been penned, advancing claims for the origin in many different parts of the world.

When we seek for the primitive meaning of this cross we are on even more debatable ground. Theory after theory confronts us, the advocates of widely differing views arguing at times with astonishing positiveness, and adding assertion to evidence. All may agree, however, that the Swastika was made at the first with a definite intention and meaning, passing from tribe to tribe. Madame Blavatsky said that "it is at one and the same time an alchemical, cosmogonical, anthropological, and magical sign, with seven keys to its inner meaning." Well argued claims have been presented that the device was first suggested by forked lightning, and so became a representation of the weapon of the air-god, and the emblem of Zeus or Jupiter as supreme. In Scandinavia it was the hammer of Thor, and some assert found its beginnings in that country. Again it is held that the process of "churning" the sacred fire with crossed sticks led to the use of the form as a sacred symbol representative of the act or of the "vital flame" itself. Again, by a series of evolutions, it has come from the representations of that "fetish of immemorial antiquity," the lotus. Again, it represents the four cardinal points, and is the supreme symbol for the cult of the cardinal points. By it the four winds of heaven are indicated. It was suggested by the arrangement of stars at certain seasons of the year. In some parts of the world it was evidently a symbol of the earth. It is said to represent in its short arms Time, in its long ones Eternity. One other theory seems to be so well supported by various lines of evidence as to warrant some elaboration. Suggested by a number of independent scholars, it has received an able presentation by Mr. William Simpson. The sun in the earliest times must have been an object of wonder and worship. From it came light, heat, health, wealth. It appeared as a circle in the heavens, and by its turning movement the succession of the seasons were insured. The wheel or circle, one of the oldest symbols, common to Brahmanism and Buddhism, but antedating them, and almost universal in use, would naturally be a symbol of this benevolent object or deity. It would come naturally to represent the idea of dominion, power. From the presentation of the merely physical aspect it would be natural to attribute to the wheel the additional idea of the right, true way, the beneficial path, and so the law. Whatever was according to the path of the sun was of the good way, and that not so was false, of decay, and death.

The Swastika also is one of the oldest of symbols, and well nigh universal. Mr. Edward Thomas, one of the first authorities on Indian coins, wrote: "So far as I have been able to trace or connect the various manifestations of this emblem, they one and all resolve themselves into the primitive conception of the solar motion, which was intuitively associated with the rolling wheel-like projection of the sun through the upper or visible arc of the heavens as understood and accepted in the crude astronomy of the ancients." Prof. Max Müller speaks of this explanation as decisive, saying: "The emblem of the sun in motion, a wheel with spokes, was actually replaced by what we now call the Swastika; that the Swastika is, in fact, an abbreviated emblem of the solar wheel with spokes in it, the tire and the movement being indicated by the crampons." In further support of this claim the form of the Swastika is urged, rays in motion, and also that the objects most frequently associated with it are representations of the sun and solar divinities. In some combinations the symbol alternates with signs of the sun. An antique represents Apollo in a car with a Swastika on his breast. A water bottle, discovered at Moundville by Prof. Moore, bears an incised decoration of a winged sun and solar ray emblems, and another bottle a Swastika in a circle. The Empress Wu of China, about 704 A. D., invented an emblem of a Swastika inclosed in a circle, the sign for sun. A Greek geometric vase in the British Museum shows the symbol between two solar geese. Many other examples might be quoted.

This explanation of the genesis of the Swastika and its early associations does not require the giving up of other symbolisms which may have been attached to it. Advocates of the sacred fire, the "Lucifer" of primitive man, of the four cardinal points, and the four winds, may still read their favorite meaning in the cross.

As regards the two forms of the emblem there is, of course, a diversity of opinion. The one which "kicks to the left," connects with death, and refers to the circlings at funerals, which are against the sun, the way of evil, decay. Still we find many examples of the left Swastika used like the other. Mr. Landon, relating his observations in Tibet, says: "It is said that the Swastika which revolves to the right is consecrated to the use of orthodox Buddhists of whatever school, and that the Swastika which kicks in the other direction is used only by the Bennpa, the original devil worshipers, whose faith was ousted by the adoption of Buddhism. This is not borne out by the relative frequency of the position of the two Swastikas in Tibet. The left-handed Swastika (i. e., the one which turns to the dexter), is, if anything, the commoner of the two, and the commonest use of this symbol is in the opposition of the two kinds; thus the two halves of a doorway, or the pattern of a rug, will generally offer an example of the two kinds confronted." Col. Waddell, an authority on Buddhism, ascribes this, however, to the ignorance of the Lamas. More to the point than the modern use in Tibet is the fact that on objects found by Dr. Schliemann, right and left Swastikas occur together. Prof. Müller insists that the Sanscrit name refers properly only to the cross with arms pointing to the right, and that the name of the other is Sauwastika. But without reference to the name, we may agree that general use indicates that the direction of the arms is of secondary importance to the symbolism.

It was probably an easy transition for the Swastika cross, beginning with whatever signification, to take on the nature of an amulet or good-luck sign, and finally to be used as the horseshoe is so largely in our day, with purely superstitious idea. In parts of Italy the traveler sees large rudely-formed Roman crosses marked on the doors and sides of the houses of the peasants, showing the degradation of the Christian symbol to a similar use. Bibles have been put against doors to keep out the evil spirit. The Swastika use, carried to far distant lands by migrating peoples, would thus be the more likely to lose its original meaning. But the charms now sold in our jewelry stores may, after all, really carry us back, however ignorant the wearer be of it, to the days of the worship of the sun, to the time of the sacred fire.

* Abstracted from Records of the Past.

LIABILITY OF VARIOUS TREES TO LIGHTNING STROKE.

Of 1,100 trees which are known to have been struck by lightning in Belgium in the twenty-three years beginning with 1884 and ending with 1906, says Prometheus, more than 55 per cent were poplars, and nearly 14 per cent were oaks. Elms make up 7 per cent of the casualties and conifers of all kinds another 7 per cent. All experience teaches that isolated trees are most injured by lightning. The frequency of lightning strokes in trees increases

rapidly from April to a mamixum in June, diminishes slightly in July and rapidly from August to October. The stroke does not always burn the tree or leave any visible mark. The character and extent of the injury depend both on the intensity of the electrical discharge and the resistance and anatomical structure of the tree. In large forests of deciduous trees with fleshy leaves the occurrence of distinct strokes of lightning is prevented by a continuous interchange between the (usually) positive electricity of the air and the (usually) negative electricity of the earth, through the stratum of air immediately over the trees, which is saturated with water vapor and thus made conductive by evaporation from the leaves.

Rohrkohl arranges trees in four groups, with respect to their liability to be struck by lightning.

1. Trees of which both wood and leaves are good conductors. This group includes most deciduous trees that have light green and comparatively fleshy leaves, such as the linden and the beech. The silent discharge passes readily through trees of this class and consequently they are seldom "struck" by lightning.

2. Trees with well conducting wood and poorly conducting leaves. This group includes such trees as poplars and oaks, which have dark green and rather dry leaves. Foliage of this character offers considerable resistance to the passage of electricity, which consequently accumulates at the obstacle and gives rise to sudden disruptive discharges, or lightning strokes. Hence trees of this class are especially liable to injury from lightning.

3. Trees with poorly conducting wood and poorly conducting leaves. This group includes most of the conifers. Owing to the small conductivity of the stem little electricity can be accumulated, hence even solitary trees of this group are seldom injured by lightning.

4. Trees with poorly conducting wood and well conducting leaves. This group includes larches and pines. These trees are almost immune to lightning, because the small quantity of electricity which reaches the crown from the earth is quickly neutralized.

This classification is not absolute, but a tree of a given species may fall into one or another group according to location and peculiarity of growth, and to the character of the soil. In conifers the electrical property of pointed conductors comes into play, their pointed crowns and leaves facilitating the silent discharge and rendering them less susceptible to injury than trees with open heads and broad leaves.

BARLEY AND ITS CULTIVATION.

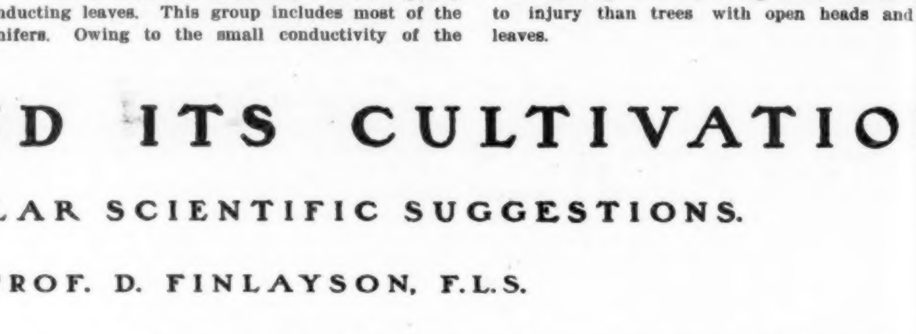
A FEW POPULAR SCIENTIFIC SUGGESTIONS.

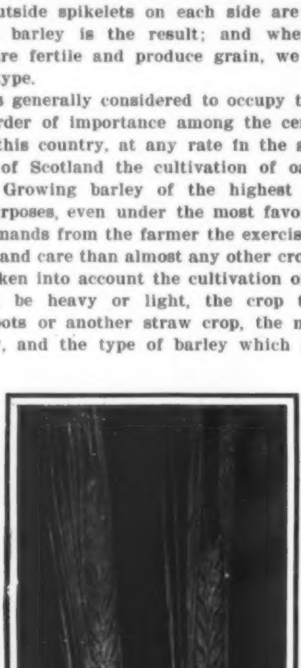
BY PROF. D. FINLAYSON, F.L.S.

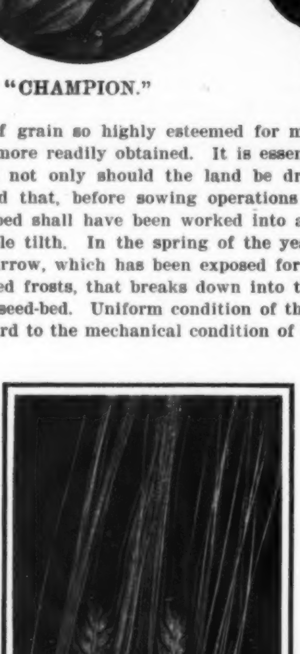
AT one time botanical authorities differed considerably as to the number of species and varieties of barley comprising the genus *Hordeum*, but now it is considered that all grown by the farmer are varieties of one species only, and that the original type is the two-rowed barley. The varieties commonly cultivated are *Hordeum sativum distichon* (two-rowed), *Hordeum sativum vulgare* (four-rowed), and *Hordeum sativum hexastichon* (six-rowed barley). In examining an ear of barley it will be seen that the spikelets are arranged in threes on opposite sides of the rachis. When the middle spikelet on each side produces one well-developed grain only, we have what is known as a two-rowed barley, the side spikelets being abortive. When the two outside spikelets on each side are fertile, a four-rowed barley is the result; and when all the spikelets are fertile and produce grain, we have the six-rowed type.

Barley is generally considered to occupy the second place in order of importance among the cereal crops grown in this country, at any rate in the south. In the north of Scotland the cultivation of oats supersedes it. Growing barley of the highest class for malting purposes, even under the most favorable conditions, demands from the farmer the exercise of more knowledge and care than almost any other crop. There must be taken into account the cultivation of the soil, whether it be heavy or light, the crop to follow, whether roots or another straw crop, the manure to use, if any, and the type of barley which it is best to sow, for each of these has an influence on the production of a uniform, mellow, well-matured grain.

In aiming at growing barley of the highest class it is essential that certain facts should always be remembered. Barley should be grown on a barley soil, that is to say, on soils of a free working character, such as light loams, sandy or calcareous soils. On heavy soils the general bulk of the produce, both straw and grain, may be considerably augmented, but at the expense of quality; whereas when barley is grown on light soils, and other conditions are favorable, the quality of grain so highly esteemed for malting purposes is more readily obtained. It is essential to success that not only should the land be dry, but also clean, and that, before sowing operations commence, the seed-bed shall have been worked into a deep, fine, and friable tilth. In the spring of the year it is the winter furrow, which has been exposed for some time to repeated frosts, that breaks down into the fine and "kindly" seed-bed. Uniform condition of the soil, both with regard to the mechanical condition of the surface and its general fertility, is really the secret of successful barley-growing. If grown after a crop of roots, any portion of the ground which has been "poached" or trodden by sheep when it was wet should receive special attention. It is infinitely better, when it can be managed, to produce the fine tilth required by exposure to natural atmospheric agencies than to force a tilth by excessive use of the harrow and roller. It happens on many occasions that the seed has apparently been sown under the best possible conditions, may be drilled on a dry, mellow surface, yet the result does not appear satisfactory; the plant has made a fair start, but seems to have received a check of some kind. The farmer, when viewing his crop, ponders over the disappointing outlook. What is the cause or reason of the failure? Oftentimes the reason is simply this—that the various tillage operations necessary for the formation of a good seed-bed are not properly timed as to the weather conditions. It is quite possible for the surface of the soil to be worked into a fairly fine condition, while at the same time the tread of the horses has formed a pan or layer impervious to the passage of water a little way below the surface; the latter being fine, the water rises readily—too readily—by capillary attraction, thus cooling the upper layer of soil and checking the growth.


Bad Good
"CHAMPION." MALTING SAMPLES. "CHAMPION."


CHEVALIER BARLEY.


GOLDTHORPE BARLEY.

While the order of succession in which crops are usually grown is dependent upon the nature of the soil and climatic conditions, it would be thought in certain districts and by some farmers little short of rank heresy to advocate the growth of two white or straw crops in succession. It is also, perhaps, well known to most practical men that there is no greater fallacy in farming practices than the laying down of rules. Phosphates and nitrogen must be both present in sufficient quantity in the ideal barley soil, but the latter element not in excess. The orthodox method of cultivation—"barley after roots"—has given place in many districts to "barley after wheat." Though the opinions of practical men differ considerably on this important departure from established custom, it is in the main a matter of individual experience and depends on the fertility of the soil. For malting purposes there are practically only two types of barley grown in this country, and these are the long-eared or Chevalier type, and the broad erect-eared type as exemplified by the Goldthorpe, both two-rowed barleys. The long-earned type was introduced early in the last century by the Rev. Dr. Chevalier of Debenham, Suffolk, and for a great many years has been grown for malting purposes, almost to the exclusion of every other type. The erect-eared type (Goldthorpe), introduced by Carters about twenty years ago, was selected and grown from a single ear found in a growing crop of Chevalier on the farm of Mr. William Dyson, a Nottinghamshire farmer. The robust appearance of the plant attracted attention, and it was noticed that the length and strength of the straw, combined with the erect, wide, closely-packed ear was something entirely distinct from the other plants surrounding it. The seed was saved and sown, and a few years later

this new variety was introduced into general cultivation. The special feature of the Goldthorpe type of barley is its stand-up character, the stoutness of its straw enabling it to withstand weather and adverse soil conditions without much danger of "lodging." It also may be successfully grown on land of a heavier class than is usually considered suitable for successful barley-growing.

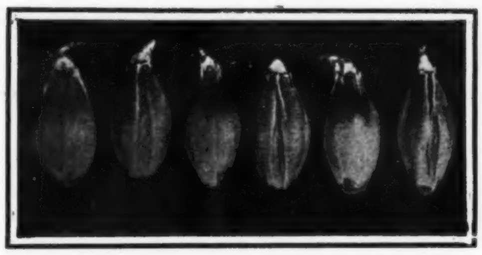
In the interests of all concerned it is of the first importance that farmers should realize that in three seasons out of four, it is the early sown barley that is likely to yield the best sample at harvest time, also the necessity of growing a true pure strain, whether of the long-eared or erect-eared type, and not to sow, at any price, a mixed lot. Mixed grain will of necessity lack two vital and essential characteristics of quality, viz., that of uniformity in ripening and composition. Within the writer's knowledge during the last few months many, very many, farmers all over the country have had considerable difficulty in finding a market for their barley, and this state of affairs is entirely due to the fact that when the merchant submits the barley to an expert, to report upon as to its suitability for seed purposes, it is found to be a mixture of two or more sorts and entirely unfit for sowing.

In handling a sample to determine whether it is good for malting purposes, there are indications of quality that are apparent at a glance—the grains are of a fair size, short and round, rather than long, thin-skinned, and wrinkled, uniform in size and of a pale yellow color. The magnified sample of grain shown here is that of the Champion barley of 1906, exhibited by John K. King & Sons at the Brewers' Exhibition. It is of the long-eared Chevalier type, and the points referred to above as illustrating a good sample can be readily detected in the photograph. A good malting barley must of necessity be a good growing one; the purity of any sample, however high, is no guarantee of its quality and usefulness if it fails to respond, and that speedily, to the test of germination. If the sample should be found weak in responding it is worthless to the maltster. The germinating grains illustrated were inclosed between folds of moistened felt, and then placed in a germinating chamber and kept at a temperature of 75 deg. F., and responded to the test as shown in thirty hours.

In many laboratory experiments during recent years it has been found that the amount of water present in the grain influences very materially the rapidity of germination, the drier grains in almost every case germinating more quickly and regularly than those containing a higher percentage of moisture. The quantity of water present in the grain is dependent upon its condition when cut, its ripeness, the mode of harvesting and sweating in the stack before threshing. The importance of the moisture content of seed barley has also been demonstrated in field tests. Barley which had been kiln-dried at a temperature varying from 90 deg. F. to 120 deg. F. for twenty-four hours germinated more evenly, and with this result—that

SIX-ROWED BARLEY.

when the barley was threshed the uniformity and maturation of the sample was such that the grower received 3 shillings per quarter more for the produce of dried seed over the undried. While the size of the barley grains determines the amount of brewing material obtained, it is mainly, if not entirely, the maturation of the grain which determines the quality of the same. Perfect and imperfect maturation of the grain is well seen in the magnified section of two barley grains (see illustration). In the former the maturation seems to be complete, and the ruptured starch cells give a white and mellow appearance to the transverse section. In the section on the left showing imperfect maturation, the hard, horny appearance of the cut surface is a striking evidence of the absence of that essential quality possessed in such high degree by the other. It is well known that, when growth has ceased, and the barley has become dead ripe, between the time of cutting and carrying the grain to the



GERMINATING AFTER THIRTY HOURS TEST.

stack further maturation takes place—if the weather conditions be favorable—due to the alternate slight wetting and drying, thereby adding to the malting quality of the grain.—Country Life (London).

THE PRACTICAL GOOD OF ASTRONOMY.*

By Prof. Harold Jacoby.

There are at least three practical things that astronomy does for us; and without these modern civilization and modern life would be impossible. The first is the regulation of time. Few persons stop to think how this is done to-day. When we desire to set our watches or clocks aright we simply compare them with an accurate timepiece called a regulator such as may be found in every jeweler's shop. But how does the jeweler regulate his regulator? In every city there is a network of telegraph circuits. One of these is called the "time-wire." For a moderate annual compensation, the telegraph company will run a loop from the time-wire circuit into any building. A telegraphic sounder is attached to this loop, and thus the beats of a standard clock placed in the central office of the telegraph company can be repeated by the sounder for comparison with the jeweler's regulator. By a simple system of omitting one beat before the beginning of each minute, and a different number of beats before the beginning of the hour, it becomes possible to adjust the minute and hour hands of the jeweler's regulator as well as the second hand into accord with the company's standard.

But this simply transfers our problem from the jeweler's regulator to the company's standard, and would be of no use so far as accuracy is concerned, if we had no means of correcting errors in the running of the standard itself. Of course this clock is always made very carefully, and no expense is spared in assuring the greatest precision in all its mechanical parts, so far as precision can be attained by the work of human hands. In spite of all precautions, however, slight errors will occur, and these may accumulate into quantities of quite considerable magnitude as time goes on. To correct them, we must have recourse to a natural standard of time, we must appeal to the stars themselves, and here we need the astronomer.

It is unnecessary at this point to enter into any detailed explanation of how he performs his part of the work. It will suffice to point out that the instruments mounted in any modern permanent observatory enable him to determine the error of his clock within a very few hundredths of a second by an hour's observations on any clear night. A telegraphic comparison with the company's standard then transfers this accurate determination of clock error to the latter instrument, from which it is in turn distributed to the jewelers' regulators, and from them to the people at large. This work is important, essential even; but it requires one astronomer only, very little of his time, is purely routine in character, and cannot be called research in the full sense of the word.

The second definite function of astronomy in practical affairs has to do with navigation. The sure and certain guiding of a ship across the trackless, unmarked ocean is one of the many things startling, even mysterious to the layman, though simple enough to those conversant with the underlying astronomical principles. The navigator determines the position of his ship day after day by observations with an astronomical instrument called a sextant. But these observations alone would be of little value. They are but the raw material, and must be subjected to a refining process called "reduction" or computation before they will furnish the information desired. To carry out this process of computation the navigator needs certain printed astronomical tables, that give him the positions of the sun, moon, and other heavenly bodies on the sky for every day in the year.

These tables are published by the various civilized governments of the world, and are called nautical almanacs. In their preparation we need again the services of one skilled astronomer, to superintend the work, and to assist him a corps of more or less mechanical assistants and clerks. Like the regulation of time, this work is indispensable, but it is again almost altogether an affair of routine at the present day, and does not partake of the nature of genuine research.

The third practical use of astronomy to which I shall venture to call attention has to do with the preparation of maps and charts. The ordinary processes of the surveyor need but to be strengthened by increased power of instruments and increased precision of observation to make them applicable to charting larger portions of the earth's surface, such as an entire continent or the coast lines of a great country. But when such maps and charts have been thus completed, they furnish merely a correct picture of the earth's surface—showing towns, rivers, bays, and capes in their proper relative positions. In this form they are not of any great practical use. To perfect them, it is necessary to mark upon them the latitude and longitude lines, and these cannot be placed correctly without the aid of astronomical observations. The latitudes and longitudes of a number of points covered by the survey must be determined astronomically, and then the proper reference lines can be inscribed on the charts to complete them. However important to commercial civilization, such work is outside the pale, and seldom comes within my notion of what constitutes true research.

Utilitarian motives are not inferior to research; they are not superior to research; they are not equal to research; they are simply other than research.

And now permit me to illustrate my ideas still further by describing briefly a modern research that seems to me genuine, absolutely. I select for this purpose a piece of work by Gauss, he who was called, rightly, by those of his contemporaries who were wont to follow the good old custom of writing in the Latin language: Gauss, clarissimus; Gauss, celeberrimus; and, finally, Gauss, incomparabilis.

It was on the very first day of the nineteenth century that Piazzi of Palermo discovered the minor planet Ceres, the first to be added to the seven previously well known. Illness prevented Piazzi from observing the new object during more than six weeks; and as news of planetary discovery traveled slowly in those days, it was not until the latter part of March that astronomers in northern Europe heard of the new object. By that time Ceres had passed so near the sun that it could not be observed, and great excitement resulted from the fear that it would never again be found, because astronomers would not know exactly where to look for it when the time should again come to attempt observation.

FOUR-ROWED BARLEY.

And there was good reason for this fear. The older planets had of course been observed throughout many orbital revolutions, and it was a difficult, unsolved problem to determine the path of such a moving body when the available observations extended through a very small fraction only of the planet's total circuit around the sun. Without a satisfactory solution of the problem, a further search would be well-nigh hopeless when it should again become possible to undertake one.

* Abstracted from a lecture on Astronomy delivered at Columbia University in the series on Science, Philosophy and Art.

Gauss was then a young man of twenty-three at Göttingen. He attacked the difficulty, overcame it, and his computations made the re-discovery of Ceres easy in the following December. He had produced his deathless work on the theory of motion, but he spent eight long years perfecting it before he gave it to the press. When it appeared, the world possessed one more true work of art. Fallible and imperfect must ever be the results of human effort. No one can reach his ideal. But the *Theoria Motus* stands immaculate, unapproachable, such as might be a marble of Phidias; none have since added anything to it. This is in truth a hall-mark of art, that the thing itself shall approximate perfection; shall be the utmost effort of the utmost man.

THE TRANSPLANTING OF FISH.

WHAT HAS BEEN DONE BY THE FISH COMMISSION.

BY HUGH M. SMITH, DEPUTY U. S. COMMISSIONER OF FISHERIES.

ONE of the most important, extensive, and interesting lines of utilitarian work conducted by the federal government is the transplanting of native aquatic animals into waters in which they are not indigenous, and the introduction of fishes of foreign countries into the United States. Most people are familiar with the economically important results of acclimatizing foreign species or varieties of mammals and birds in our country, and every one can recall some of the many valuable vegetables, fruits, and other plant products that are immigrants; but comparatively few people are aware of the systematic and varied measures that have been taken by the government for increasing and enriching the supply of food and game fishes of every section of the country.

When we contemplate our wonderful aquatic resources, the question naturally arises as to the necessity for planting non-indigenous species in any of our waters. The occasion for such efforts comes from a number of conditions which have been duly considered by the authorities; among these are:

(1) The depletion of the indigenous fishes of given waters and the inability to secure the re-establishment of those species, either by restrictive measures or by artificial propagation, owing to changed or changing physical or biological conditions.

(2) The possibility of enriching the fish fauna of a given water by introducing more useful species than already exist therein or by affording a greater variety of fishes for food and sport.

(3) The existence of physical or other conditions more inimical or unfavorable to the native fishes than to other fishes that might be introduced.

(4) The possibility of relieving the drain on native species by providing new objects for the pursuit of the angler and the commercial fisherman.

(5) The desirability of reducing the abundance or securing the extermination of noxious fishes and other water animals by planting fishes which will prey thereon.

Features of aquatic acclimatization which may be noted especially are in the interchange of products between the eastern and western parts of the country, the introduction of eastern fishes into new waters of the East, and the importation into the United States of fishes from foreign countries. This work has affected not only the lake and pond fishes, but also the migratory river fishes of both seaboards and some strictly salt-water forms; and since, for practical purposes, the term "fish" has generally been construed as meaning every kind of animal taken from the water for profit or pleasure, the operations have involved many creatures that the biologist would not class as fish.

The seemingly benign and beneficent work of transplanting water animals is not wholly free from possibly harmful results, analogous to those that have attended the transplanting of land animals, of which the rabbit in Australia, the mongoose in Jamaica, and the English sparrow and Norway rat in America are well-known examples. Great care has been exercised by the Federal Fishery Bureau in making plants of non-indigenous fishes, and injurious results chargeable to it have been extremely rare; but eternal vigilance is necessary, and many applicants for fish become disgruntled because they are not permitted to have their own way.

Some of the States have been quick to recognize the necessity for restricting the planting of non-native fishes, and have enacted laws prohibiting the introduction of any fish not approved by the State authorities. One of the most persistent demands on the Bureau of Fisheries is for black bass to stock western waters that already contain an abundance of trout or salmon. Such practice is little short of criminal, and in all such cases where there is reason to fear that valuable trout waters may be ruined the Bureau takes the precaution to defer to the judgment of the State fishery officers.

One of the most unfortunate instances of the destruction of one species by another is that of the grayling, a superb food and game fish of which only three colonies had survived some cosmic cataclysm and had become established in regions as isolated as Alaska, Montana, and Michigan. In the last-named State trout were recklessly planted in some of the few streams inhabited by the grayling, with the result that the grayling has become completely exterminated therein.

With the transplanting of eastern oysters on the western seaboard, there has been introduced one of the small boring mollusks or drills which is very injurious to oysters on the Atlantic coast and is maintaining its reputation in California. It has become very abundant, and several years ago was reported to be destroying annually oysters to the value of $30,000.

Another unfortunate case of accidental or unintentional acclimatization is that of the alewife in Lake Ontario. By means of canals, the alewife found its way from the Delaware or Hudson River into Lake Ontario, and there soon became excessively abundant; but lack of food or the changed habitat resulted in a stunted race of no economic value, and furthermore this fish is subject to a periodical epidemic which kills millions each season; these pile up on the shores or pollute the water, and prove such a menace to health that the local authorities are often put to considerable expense in removing them. It is possible, however, that by serving as food for other fish the alewives in Lake Ontario are saved from the stigma of being unmitigated nuisances.

In all the waters of the eastern half of the country the range of all the important native food and game fishes has been extended artificially. Very extensive work has been done with the black basses, the crappies, the rock bass, the brook trout, the land-locked salmon, the lake trout, and the more desirable catfishes, while a number of very excellent fishes with restricted original distribution have been judiciously scattered and thus brought to the notice of thousands of people who would otherwise never have known them.

The debt that sportsmen owe to the fishery service of the United States and the several States for their acclimatization work is heavy and increasing yearly, and the obligation is shared indirectly, but not the less actually, by hotel-keepers, boatmen, merchants, land-owners, and others. There could be cited numerous concrete examples of the varied benefits that have come to communities through the stocking of local waters with non-indigenous species. In some cases the improvement in the fishing has so increased the influx of people that land about the waters has increased several hundred per cent in value in a few years.

But there is no evidence of the existence of salmon in the Hudson, except possibly as mere stragglers, at any time during the eighteenth century or in the nineteenth century, until about 1890, when the national government, co-operating with the State of New York, attempted to establish the salmon in this noble river—a feat that would have meant a great deal to anglers, net fishermen, and the general public.

It is a matter of no little interest that as early as 1771 the colony of New York had under consideration the question of transplanting salmon from Lake Ontario or from neighboring rivers to the Hudson, and in that year, at the instance of the corporation of Albany, a law was enacted prohibiting for a term of years the taking of such introduced fish. This project, however, does not appear to have been followed up, and it remained for the present generation to give it a trial. The States bordering on the Delaware were also solicitous for the introduction of salmon into that stream, which had never contained salmon, and the test was made therein about the same time.

Of the many salmon streams that New England once had, the only one that has survived is the Penobscot, and this has been maintained solely by artificial means, for natural spawning has for some years practically been suspended. It was at the well-known salmon hatchery located on Craig Brook, a tributary of the Penobscot, that the young fish for stocking the Hudson and Delaware were hatched and reared. Rather liberal plants were made for several years, beginning in 1890, and in the fifth year after the first deposits mature fish began to be caught in the nets of the shad fishermen. It is a matter of record that over 300 salmon weighing 10 to 38 pounds were caught illegally in the Hudson in 1895, and fully 300 were taken in the Delaware in the same year and sold. This gratifying outcome was widely heralded as establishing the feasibility of inducing a permanent supply in these rivers; but, unfortunately, when the planting of young fish was discontinued, the run of adult fish in due time declined, and to-day those waters are as free from salmon as they ever were. These efforts, however, were not altogether useless, since they showed (1) that the young fish ran to sea, remained in the vicinity of the rivers until mature, and then were impelled by the spawning instinct to return to the same rivers, and (2) that the streams proved unfavorable for natural reproduction, for there is little or no evidence that effective spawning took place.

Whether the making of large plants for a long series of years would eventually establish the salmon in these two rivers and in others formerly inhabited by the fish is perhaps an open question, but to my mind is very doubtful. The physical conditions in most of our northern streams are each year becoming more unsuitable for such species because of obstructions, pollutions, clearing of forests at their headwaters, etc.; and if it is possible to establish any kinds of salmon therein the greater chance for success lies with some of the less fastidious western species.

As an example of what may be done for a large stream in the way of beneficent acclimatization, the case of the Potomac River may be cited. The most valuable non-indigenous fishes now inhabiting the Potomac are the small-mouth and large-mouth black basses. Ichthyologists and fish culturists are well aware that these most excellent food and game species are not native to this river, but their introduction occurred so long ago that the general public has lost sight of the interesting facts connected therewith. It was in 1854, shortly after the completion of the Baltimore and Ohio Railroad, that a lot of small-mouth black bass from the Ohio River were brought east in the water tank of a locomotive engine and liberated in the basin of the Chesapeake and Ohio Canal at Cumberland. Having free access to the Potomac, the fish soon found their way to various parts of the river, and inside of ten years literally swarmed in all the tributaries from Mount Vernon to the headwaters. At the present time the species affords much sport from Washington to Harpers Ferry and beyond, but is not common below the capital. The introduction of the large-mouth black bass into the Potomac basin was accomplished by the Bureau of Fisheries in 1889, the first plants being made in the Shenandoah and later in the vicinity of Washington. By 1896 the fish had become remarkably abundant, and now it is taken in large numbers by net fishermen and anglers in all the lower fresh-water reaches of the river.

The strawberry bass and the crappy were established in the Potomac by the Bureau of Fisheries in 1894, and both are now common in a long stretch of the stream from Alexandria upward. Other members of the bass family that have been colonized in the Potomac are the rock bass, the warmouth, and the blue-gill.

As a result of plants of fry between Washington and the Great Falls, the wall-eyed pike or pike perch, the largest and most valuable member of the perch family, has been acclimatized and for five or six years has been attracting attention. It is not yet very numerous, but apparently is becoming more so each season and in time should prove a valuable addition to the supply of fishes caught for market and for sport.

Not the least important of the additions to the Potomac fauna are two catfishes from the Mississippi basin. One of them, the spotted or blue cat, is probably the best of the tribe, inhabiting cold, running water, having dainty feeding habits, possessed of game qualities scarcely inferior to those of the bass, and being excellent food. Small plants of adults and yearlings were made at Quantico, Virginia, and Woodmont and Hagerstown, Maryland, in 1889, 1891, and 1892; and since 1899 the fish have been taken in increasing numbers each year, especially between Washington and Little Falls, many of them weighing 10 to 20 pounds. Recently there have appeared in the river

considerable numbers of another species, the great fork-tailed cat, of the introduction of which there was no record; so it is evident that the young were mixed with the spotted cats and were overlooked when the plants were made. This fish reaches a weight of more than 100 pounds in its native waters, and examples taken from the Potomac by line fishermen have weighed upward of 30 pounds.

Probably the most noteworthy results attending the introduction of aquatic animals into new regions have been seen in the Pacific States, and represent contributions from the eastern seaboard. Among the eastern fresh-water fishes that have been firmly established and more or less widely colonized in the Rocky Mountains or in regions beyond the mountains are the large-mouth black bass, the crappy, the yellow perch, the pike, several catfishes, various sun-fishes, the land-locked salmon, and the brook trout. The sportsmen of all the western States are now afforded excellent black-bass and brook-trout fishing. Migratory eastern river fishes that have been permanently introduced into the Pacific streams are the striped bass and the land shad, and the economic results therefrom are without parallel in the entire history of migratory fishes. Chief among the marine invertebrates of the Atlantic coast that are now found on the west coast are the oyster and the soft-shell clam.

Colorado, which has known the eastern brook trout for only a few years, is now more thoroughly stocked than any other State. So successful has been the work of acclimatization in Colorado that the government now draws on that State for most of its supply of brook-trout eggs, which are obtained chiefly from wild fish in mountain streams and lakes; and it is in accord with the eternal fitness of things that the progeny of Colorado brook trout should be used for replenishing the very eastern waters from which the original stock was taken for introduction into Colorado.

It is generally conceded that the Yellowstone National Park affords some of the very best trout fishing to be had anywhere in the world. The thousands of anglers who have dropped their lines in the limpid waters of that wonderland and the thousands and millions who are yet to enjoy the delights of fly-fishing and trolling amid those most inspiring scenes have been and will be indebted to the paternal solicitude of the federal government, which has not only stocked lakes and streams of the park which had from time immemorial been entirely destitute of fish life, but each season, in a quiet but effective way, takes steps to maintain and increase the supply of trouts. Furthermore, a commendable policy has been adopted and adhered to by which different kinds of trouts are kept in separate waters, so that the park gives opportunity for the most varied and at the same time the most specialized trout fishing. Thus, in one river basin the black-spotted trout exists to the exclusion of other species, in another the rainbow, in another the brook, in another the lake, and in others several European trouts.

The colonizing of the shad on the Pacific coast was one of the greatest achievements in fish acclimatization. With the experiment were associated two of the pioneer fish culturists of America, whose names and fame are known the world over—Seth Green and Livingston Stone.

It was in 1871 that the California Fish Commission made arrangements with Seth Green to take to California a lot of young shad from the Hudson River. He started with 12,000 newly hatched fish in four 8-gallon milk cans, and by indefatigable efforts succeeded in carrying his delicate wards to the Sacramento River and planting 10,000 of them at a point 275 miles above Sacramento. In 1873 Mr. Livingston Stone, of the U. S. Fish Commission, carried to the Sacramento a second lot of shad, 35,000 in number, also from the Hudson River. In 1876, 1877, 1878, and 1880 further plants, aggregating 574,000, were made in the same river. In 1885 and 1886 deposits aggregating 910,000 were made in the Columbia River. No shad fry were introduced into the Sacramento after 1880 or into the Columbia after 1886.

That the shad found the waters of the Pacific States entirely congenial was quickly demonstrated. In April, 1873, a shad 1 year, 9 months, and 20 days old and weighing 3 pounds was caught in the harbor of San Francisco, and the lucky fisherman was paid a reward of $50 offered by the California commissioners for the first shad. In a short time many more were taken in the vicinity of San Francisco; by 1879 they had become numerous; by 1883 the supply in some places was reported as almost unlimited, and a few years later the shad were regarded as one of the most abundant food fishes of California, and the price to fishermen and consumers was less than in any other State.

Shad were first taken in the Columbia in 1876 or 1877, so it is evident that an offshoot from the California colony soon migrated northward and had already established itself when the new emigrants arrived from the East, eight or nine years later. By 1881 the fish seems to have become distributed along the coast of Washington, and in 1882 reached Puget Sound. It was nine years later, however, when the first pioneer was recorded from Fraser River, and the same year there was a report of shad in Stikine River, southeast Alaska. In 1904 a fine roe shad caught at Kasilof, on Cook Inlet, was the first known arrival in that remote region. To the southward the fish is found as far as Los Angeles County, and the present range of the species thus extends along about 4,000 miles of coast.

The two great centers of the shad's abundance are the Sacramento basin and the lower Columbia River, and it has been asserted that in either of these waters more shad could be taken than in any other water-course in the country. The catch affords an inadequate criterion of the shad's abundance, for fishermen and dealers report that it would be easily possible, should the demand warrant it, to treble or quadruple the present yield, as most of the fish are now taken incidentally in apparatus set primarily for other species.

Viewed from the purely business standpoint, the transplanting of shad to the Pacific coast has been a remarkably good investment. As near as I can ascertain, the total cost of the experiment was under $4,000, and the results in California, Oregon, and Washington have been approximately as follows:

Annual catch at present time......	1,500,000 pounds
Aggregate catch to end of 1906.....	13,250,000 pounds
First value of aggregate catch..............	$302,000

Were it not that the shad has to compete with a great variety and abundance of other excellent fish, for which there is a strong predilection born of habit and sentiment, this species would be in the front rank of west coast fishes in the popular estimation. Notwithstanding its excellence, abundance, and cheapness, it is not very popular in the West, but there are indications that it is becoming more generally appreciated.

The history of the introduction of the striped bass on the western seaboard is quite similar to that of the shad, and the results have been equally striking. In 1879 the Federal Fishery Bureau planted in an arm of San Francisco Bay about 135 striped bass, mostly $1\frac{1}{2}$ to 3 inches long, from the Navesink River, in New Jersey. A second plant of 300 small fish from the Shrewsbury River, New Jersey, was made near the same place in 1882. There were no other transshipments of this species; and in contemplating the outcome of this experiment after the expiration of a quarter of a century, well may we exclaim, "How great a fishery a little plant hath made!"

The striped bass found the waters of San Francisco Bay and its tributaries as congenial as did the shad, and has shown an almost uninterrupted increase in abundance to the present time. A number of years ago the California striped-bass catch exceeded that of any other State, while now it surpasses that of any group of States along the eastern seaboard. The economic importance of the introduction of the striped bass on the Pacific coast may be judged from the following figures:

Entire cost of transplanting less than..........	$1,000
Annual catch in recent years......	1,750,000 pounds
Value of same to fishermen.................	$105,000
Aggregate catch to end of 1906......	14,960,000 pounds
Total value to end of 1906................	$812,000

The fishes which the Western States have given to the remainder of the country belong to the trout and salmon family, and up to the present represent only two species that have been actually acclimatized in eastern waters; these are the rainbow trout and steelhead trout. Experiments are now in progress with several other trouts, and, more important, systematic efforts are being made to establish several of the Pacific salmons in New England waters. If this should be accomplished, the fish debt that the West now owes the East for courtesies rendered and benefits conferred will largely be liquidated.

The foremost contribution of the West to the East is the rainbow trout. This fish, which is one of the finest American salmonoids and has long been the subject of fish-cultural operations, is native to the streams of the Sierra Nevada and the coast ranges. Beauty, large size, rapid growth, hardiness, food value, and game qualities combine to make this a general favorite. By anglers it is usually rated next to the brook trout, although many consider it fully as gamy as the latter fish.

The transplanting of this species in regions east of the Rocky Mountains has been a conspicuous success and has proved a decided boon to many communities. Its acclimatization by the general government was first undertaken in 1880, although it is probable that some years prior thereto small plants had been made in new waters by State commissions or private persons. The rainbow trout has now been introduced into nearly every State and Territory, and has become one of the most generally known fishes in every part of the country. In Michigan, Missouri, Arkansas, Nebraska, Colorado, Nevada, and throughout the Alleghany Mountain region, its transplanting has been followed by especially noteworthy results. Its position in the streams and lakes of the Eastern States is that of a substitute and not a rival of the brook trout. It is well adapted for the stocking of waters formerly inhabited by the brook trout, in which the latter no longer thrives on account of changed physical conditions; it is also suited to warmer, deeper, and more sluggish waters than the brook trout finds congenial.

Ichthyologists have not fully decided whether the steelhead trout of the Pacific coast rivers is a distinct species or only a rainbow trout that has the habits of the salmonc. In the West it is classed with the salmons because of its size and migrations; but in the East it has readily taken on the characteristics of a strictly fresh-water species, and has become a competitor of the land-locked salmon. The first successful attempt to bring this excellent food and game fish within reach of the people east of the Rocky Mountains was in 1896, when the planting of fry in rivers at the western end of Lake Superior was begun. In the following year many fine specimens were caught in those streams, and in 1898 fishermen setting nets in deep water for lake trout began to take large steelheads along the American and Canadian shores of the lake, and in the same year fly-fishermen of Duluth caught in French and Sucker rivers not less than 2,000, the largest 28 inches long. The species is now firmly established in Lake Superior and will doubtless in time spread to others of the Great Lakes. The Bureau of Fisheries has recently begun the hatching of eggs from wild fish taken in streams near Duluth. Each season eggs of the steelhead are sent from points on the Pacific coast to stations in the East where the hatching is completed, and the species has obtained a firm hold in a number of New England lakes and has proved an acceptable addition to the fish supply.

The most momentous experiments in fish transplanting now in progress are addressed to the Pacific salmons, and perhaps the greatest boon the West is destined to confer on the East is the replenishing of the New England streams with salmon. The physical conditions in the streams that formerly were inhabited by the Atlantic salmon forbid the possibility of ever re-establishing that species, but it may be that some of the Pacific salmons will find those waters congenial. Trials in the East began with the Chinook salmon—the largest and best of the tribe—and there have been a few encouraging successes reported from the St. Lawrence basin and from Maine; but it would appear that this species requires conditions that it does not find. Experiments are now in progress with the silver salmon and the humpback salmon—species of little value for canning, but exceedingly good when eaten fresh. These fish require smaller streams for spawning purposes than the Chinook or the Atlantic salmon, and the Bureau is quite hopeful that they will take kindly to many of the coastwise streams of New England, and it is not improbable that some mature specimens may be found in the Maine rivers this season.

The native oyster of the Pacific coast is a small species, with a strong coppery flavor that persists under all conditions of growth and even after cooking. It was therefore a great boon when, at a comparatively early date, the Atlantic oyster was introduced and took its proper place as the best molluskan food of the Pacific seaboard.

The origin of a very extensive California industry dependent on the Eastern oyster is said to have been due to a mere expedient to avoid loss. About 1869 a San Francisco fish firm ordered three carloads of large Eastern oysters. This was the first shipment of the kind, and the market was overstocked, so the consignees were obliged to dump a part of the cargo in San Francisco Bay. The oysters thrived and subsequently yielded a handsome profit; and this enforced experiment has led to an important trade, and to the inauguration of a system of oyster culture that has remained unique.

A number of oyster-planting companies are now engaged in bringing one- and two-year-old oysters from New York and vicinity and planting them in various parts of San Francisco Bay, where large areas are now devoted to the cultivation of this mollusk. The oysters grow rapidly, retain their native flavor, and are marketed at very remunerative prices after being on the beds for two and three years. The supply is chiefly kept up by annual replenishment from the East, the oysters being brought in refrigerator cars holding 150 to 200 barrels; some seasons the shipments have amounted to 100 or 125 carloads.

California enjoyed a monopoly of this industry for many years. In 1894 the Bureau of Fisheries made a successful plant of eighty barrels of Eastern oysters in Willapa Bay, Washington, and demonstrated to the people of the northwest coast the possibility of growing to marketable size in their waters oysters brought from the Atlantic. Private companies have now undertaken the business in Willapa Bay, Puget Sound, and several other points in Washington and in Yaquina River in Oregon, and the outlook is quite favor-

able for the development of a remunerative trade.

The one drawback to the complete success of this business is the necessity for depending on the East for keeping up the supply. This is particularly true of Oregon and Washington, where the water is too cold to permit the eggs of the transplanted oysters to develop. In San Francisco Bay, owing to the warmer water, a small but apparently increasing proportion of the output represents oysters that have been produced locally.

How large a factor in the Pacific States fisheries the Atlantic oyster has become may be appreciated when it is stated that it is exceeded in value by only the salmons, and that the annual output now reaches $600,000 to $700,000.

The soft-shell clam, accidentally carried across the continent with the oyster, has thrived well; has been retransplanted from California to Oregon and Washington, and is now yielding the fishermen an annual income of about $30,000.

In view of the foregoing splendid record of achievement, we should not be loath to acknowledge a number of failures to establish certain fishes and other water creatures in regions in which they were demanded and to which they appeared to be entirely adapted.

Between 1878 and 1888 five attempts to introduce the English sole and turbot on our Atlantic coast were unsuccessful, owing probably to the comparatively small number of fish brought over and planted. There is no reason to doubt that these species could be readily established on our northeast coast, although it must be said that the sole and turbot, choice food fishes as they are, would not be unrivaled additions to our flat-fish fauna.

One of the most surprising failures has been the entire inability to establish the whitefish of the Great Lakes in Pend d'Oreile, Cœur d'Alene, and other large lakes of the Northwest. Depth, temperature, and other conditions seem to be favorable, but for some unknown reason plants aggregating millions have been futile.

There is probably no food animal of the eastern seaboard whose acclimatization on the Pacific coast would prove such a boon as the lobster. The omission of the lobster from the Pacific fauna is regarded as a misfortune by the people of the west coast, and it was in response to this feeling that the Federal Fishery Bureau more than thirty years ago made its first move to supply the deficiency. Three other transshipments of adult lobsters were made, the last in 1889, the deposits being at various points from Monterey Bay to Puget Sound. No positive results having appeared, the Bureau renewed the attempt in the fall of 1906, and dispatched to Puget Sound a special carload of brood lobsters numbering more than all the previous plants combined, and further consignments will be made until the lobster is removed from the list of failures and recorded as a great financial and gastronomic success.—Abstracted from The National Geographic Magazine.

CELLS SENSITIVE TO LIGHT MADE WITH SELENIUM VAPOR.

IN the manufacture of selenium cells the problem is to cover a solid base with a thin and uniform layer of selenium. It often happens that the selenium, poured on in the fixed condition, fails to adhere to the base and collects in large drops. This is especially likely to occur when the base is of glass.

I have discovered that the fused selenium may advantageously be replaced by selenium vapor, which is allowed to condense on the cold base. In this way it is possible to obtain a very uniform and exceedingly thin layer of selenium which adheres firmly to the glass.

The plate should be prepared by having etched upon it, in the direction of its length, two parallel grooves and lining their ends with platinum. The plate is then exposed to the vapor of selenium. The plate must not be allowed to become hot enough to cause the selenium to collect in large drops, and it is advisable to conduct the process of sublimation in an atmosphere of dry carbon dioxide.

According to Marc, the presence of silver increases the sensitiveness of selenium cells. Hence it may be advantageous to give the glass plate, before sublimation, an extremely thin coating of silver.

Cells made by the method above described are easily protected against atmospheric and other influences and they possess the additional advantage that they cannot be short-circuited, although the electrodes are very near each other and the resistance is consequently small in comparison with the size of the cell.—W. S. Gripenberg in Physikalische Zeitschrift.

A paint for iron that is not affected by fire can be made as follows: Coat first with a solution of water glass (30 deg. Bé.) to which finely pulverized glass has been added. After drying, paint with a thin color made of 14 parts of quartz-sand, 4 parts pulverized iron scale, 0.5 part of slaked lime, 0.5 part of clay and the necessary quantity of water-glass solution.

ENGINEERING NOTES.

An inspector of bookkeeping on the Siberian Railway has invented an apparatus which registers automatically the time of arrival and departure of trains, the number of trains, and of cars, as also the number of cars in a station at any given time. It is said that this apparatus is of very simple construction. The technical department of the Russian Railway Board has examined the apparatus and declared that it is desirable that it be adopted for use at once on the Siberian Railway.

The boring operations which have been taking place for the past three and a half years near Thorne, South Yorkshire, have been successful, and a fine seam, 9 feet in thickness, has been struck at a depth of 916 yards, while 37 yards lower a second seam has been discovered, 4 feet in thickness. The Thorne Bore Syndicate, Limited, has been formed, and 15,000 acres of land have been leased by it. Other borings have been made in the district which go to show that the seam extends in many directions, dipping toward the east well into Lincolnshire. The coal is said to be of good quality, and the fact that such seams have been struck so near to the Humber should mean much to Grimsby, Hull, and Goole.

The Libyan Desert railroad, which parallels the Nile in the Western Desert from a point opposite Thebes, was described in the SUPPLEMENT No. 1703. It will connect with the main line of the Egyptian Railway at Wasta, using the Fayoum branch which ends at Gharaq. This point is only about seven miles from the coast line of the proposed Raiyan-Lulu reservoir. A well-known American engineering company has been consulted with reference to the construction of the branch from Gharaq to the Northern or Little oasis. American capital would be forthcoming for this branch, or an extension to Beni-Suef, from those who are interested in the execution of the well-known Raiyan drainage canal and reservoir project of Mr. Cope Whitehouse.

A good example of how the development of one industry helps another is found in an order for manganese steel disks recently placed in Milwaukee. This firm, in addition to manufacturing magnetic clutches, makes a specialty of lifting magnets for handling pig iron and scrap metal. The growth of this latter business and the natural desire of the manufacturers to perfect every detail of their product has led to the adoption of manganese steel for coil shields—the coil shields being the flat disk fastened to the under side of the lifting magnet for the double purpose of protecting the magnetizing coil and interposing between the two poles of the magnet an area of non-magnetic material. Brass, which is non-magnetic, has heretofore been used for this purpose. Ordinary steel will not do, because it is a magnetic metal and would serve to conduct the magnetic lines of force from pole to pole instead of compelling them to seek a passage through the material to be lifted. Manganese steel seems to be the ideal metal for this purpose. It is non-magnetic, like brass, and infinitely harder—so hard, in fact, that the continued hammering of the pig iron or other metal on the under surface of the magnet makes not the slightest impression on it. The 50-inch magnets recently furnished to a number of steel mills in the Pittsburg district are all equipped with manganese steel coil shields instead of with the brass coil shields formerly used.—Machinery.

The first application of electric motors in steel mills was made about 1892, when they replaced steam-driven and other types of hoisting apparatus, and were also used for operating overhead cranes. The crane applications were of the greatest importance; no installation is considered modern without the electric crane, and no one who has had experience with it would think of replacing it by any other type. The application of electric motors was next made to the operation of charging machines for open-hearth furnaces and to machinery for the handling of blooms and slabs. Electric motors have also been used extensively for the operation of roller tables where ease of operation and time required in handling material is of the greatest importance. The application of the motor has also been extended to screwing down rolls of bloom, slab, plate and other mills; lifting and rotating blast furnace bells; tipping Bessemer converters; operating transfer tables, saws, shears, bending and straightening rolls, blast furnace hoists, ore and coal conveyers and all the auxiliary apparatus in iron and steel mills. In a few instances motors have been used for operating blowers for Bessemer converters, but in most cases blast furnace gases are used directly in gas engine driven blowers. For the purposes mentioned, either the direct or alternating-current variable-speed types of motors are universally used. This type of motor is suitable for developing variable speed at variable torque, and is applicable where frequent starting and reversing with large torque are required. Less energy is required to perform these operations with this type of motor than with other types.

TRADE NOTES AND FORMULÆ.

Bactericide (by Aschmann).—338 parts of borax and 198 parts of glucose are melted with the addition of a little water and 124 parts of boracic acid added. The mixture is boiled down until a sample taken hardens on a plate. It is used for the preservation of animal and vegetable substances.

Planton's Paint for Iron and Wood.—3,000 parts of pulverized rosin and 200 parts of powdered shellac are melted, and while being rapidly stirred 1,000 parts of pulverized wood charcoal are added, and finally 10[illegible] parts of oil of turpentine are stirred in. The composition is applied hot with a brush or a spatula and smoothed with a hot iron. The wood or iron must be perfectly dry and free from rust or other impurities.

Water-Soluble Fat.—Take 20 parts of raw wool grease, 10 parts of American rosin, 80 parts of mineral oil, and 5 parts of soda lye of 38 deg. Be. Wool grease, rosin and mineral oil are melted together and the lye carefully added in portions, in order to prevent foaming over. Continue heating until the foaming ceases. Fat prepared in this manner can be employed as a substitute for water-soluble oil, as mold fat, etc.—Der Chemisch-Technische Fabrikant.

Impermeable Mass.—American flake graphite, [illegible] parts; finest washed graphite, 5 parts; tallow, 5 parts; ceresine, 5 parts; mineral oil, 45 parts. Melt the tallow, ceresine, and mineral oil together and stir in the graphite. To prevent the graphite from settling to the bottom, stirring must be continued until the mixture is cold. This mass is well adapted for coating asbestos packings, to prevent them burning fast and at the same time, to impart to them a greater density.—Der Chemisch-Technische Fabrikant.

To Restore Copper Plate Prints When Turned Yellow.—Fasten the print with tacks to a suitable board and by means of a soft brush wash it off very carefully with water, in which, to 1,000 parts, 50 parts of carbonate of ammonia have been dissolved. Then rinse it off carefully with clean water and repeat the operation when dry, on the back. Now moisten the paper with dilute vinegar (1 part of vinegar to 5 parts of water) and then wash with a weak calcium chloride solution (3 parts chloride of lime to 100 parts of water). Finally, rinse with clean water and dry in the open air in the sun. The paper will be perfectly white, without the print having suffered any injury.

Basalt Glazes.—Readily fusible: I. 150 parts pulverized basalt, 90 parts potash, 12 parts saltpeter. II. 120 parts of pulverized basalt, 30 parts of potash, 2[illegible] parts of boracic acid. Difficult to fuse: I. 150 parts pulverized basalt, 30 parts of potash, 15 parts saltpeter. To 10 parts of this mixture, add 3 parts of oxide of tin. II. 150 parts of pulverized basalt, 6[illegible] parts of soda. III. 150 parts of pulverized basalt, 3[illegible] parts of potash. IV. 150 parts of pulverized basalt, 30 parts of potash, 45 parts of soda. V. 150 parts of pulverized basalt, 60 parts of calcined borax. The substances must first be fritted, then pulverized and washed. If we wish to make these glazes in colors, we must add to 10 parts of the mixture selected, 2 to [illegible] parts of metallic oxide.

Egg Preservation, which is commercially of great importance.—We find in the Zeitschrift für Untersuchung der Nahrungs und Genussmittel (1907, vol. 7) a detailed investigation in which all previously suggested methods of preserving eggs are tested. As a result of this comprehensive work by Fr. Prall, of Bremen, we are able to communicate the following: (1) Fresh, clean eggs, disposed separately in a cool place, free from frost, not too damp and with good ventilation, will keep for many months, just as well as eggs placed in packing material (chaff, sand, etc.). (2) The conditions for the preservation of eggs are especially favorable in the cold storage rooms of modern refrigerating plants, in which the eggs are cooled to 32 deg. F. and kept in air of about 80 per cent relative moisture. (3) Among the processes in which the eggs are laid in fluids, that in which they are immersed in a 10 per cent solution of water glass is most commendable.

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